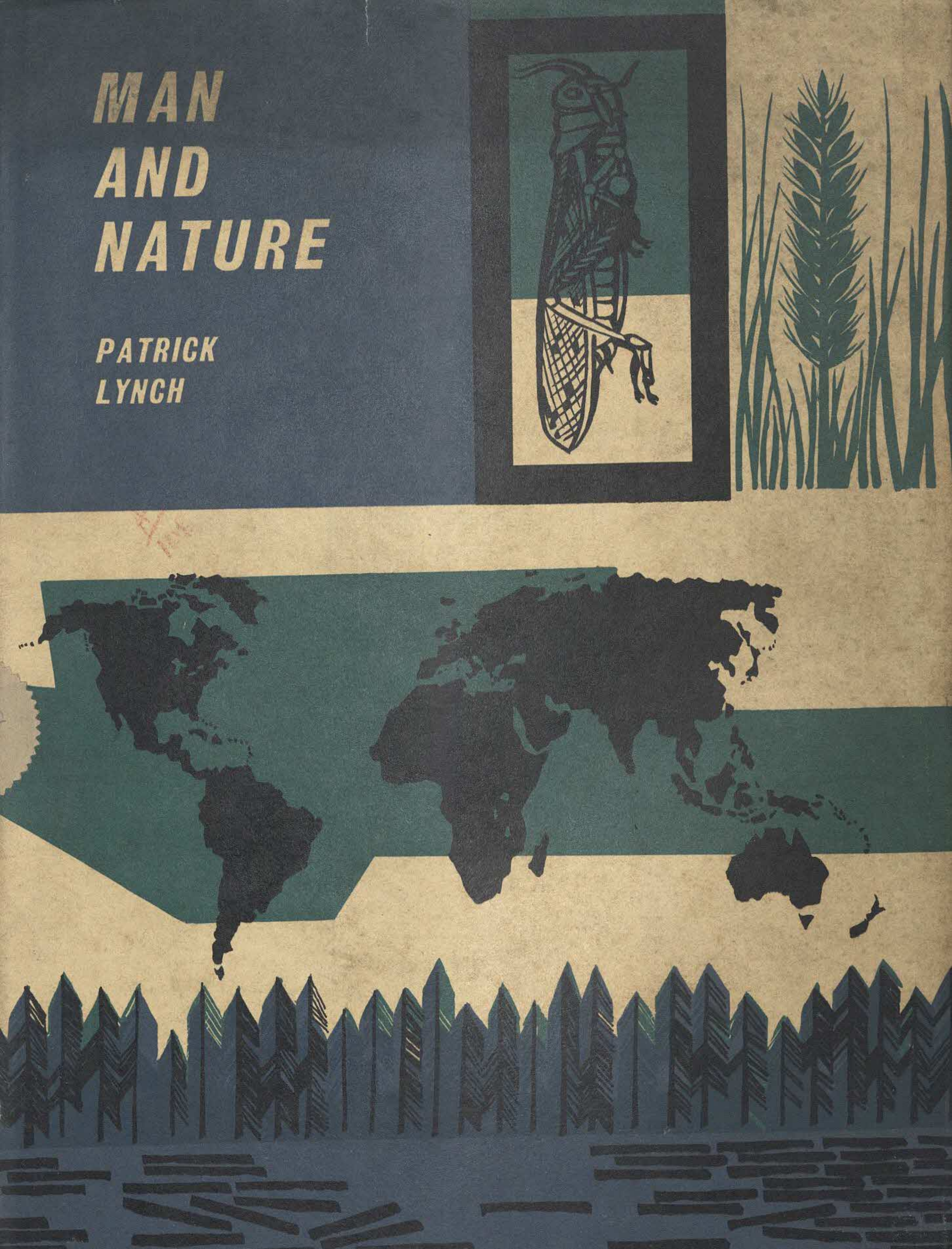
MAN
AND
NATURE

PATRICK
LYNCH



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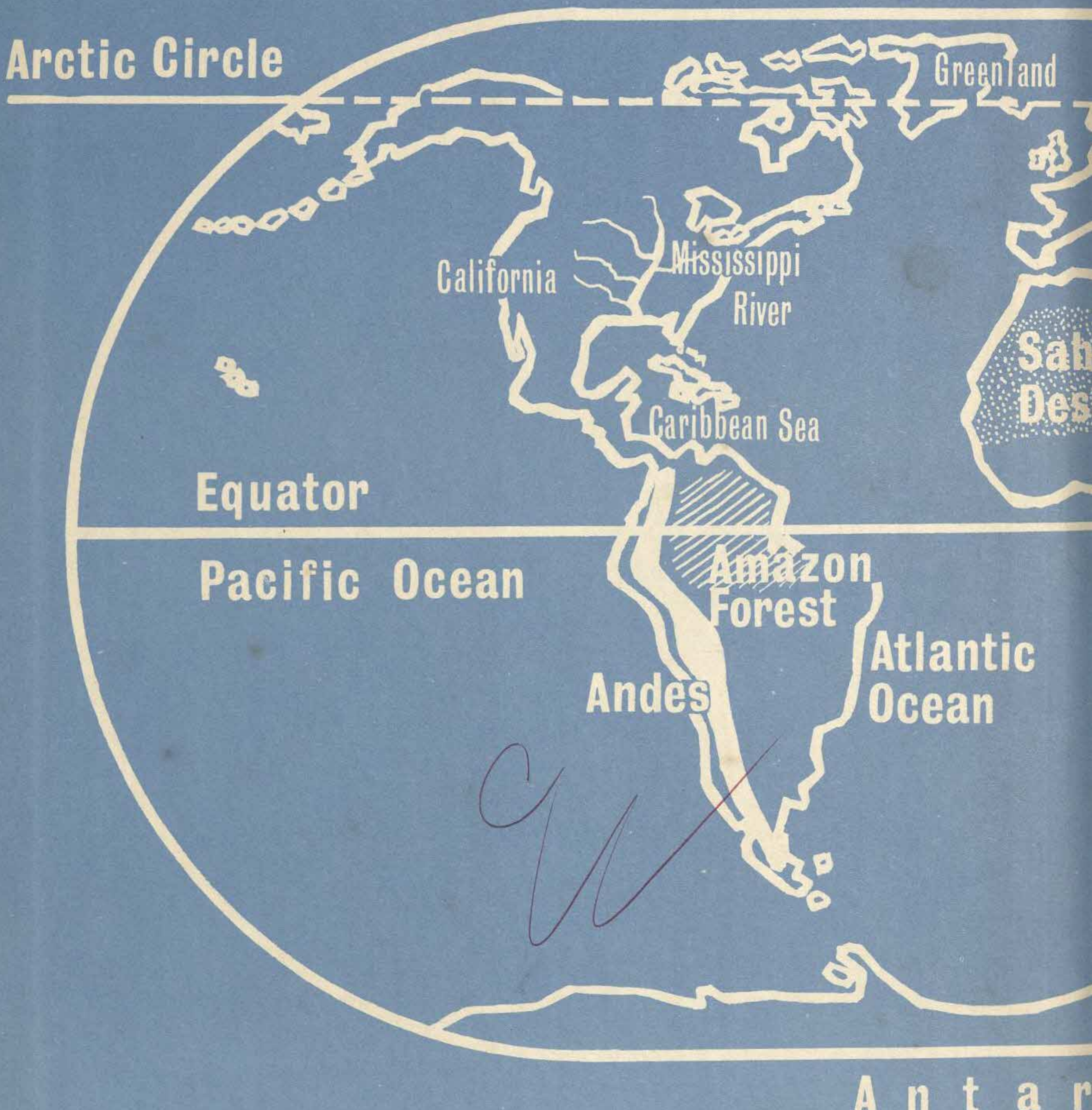

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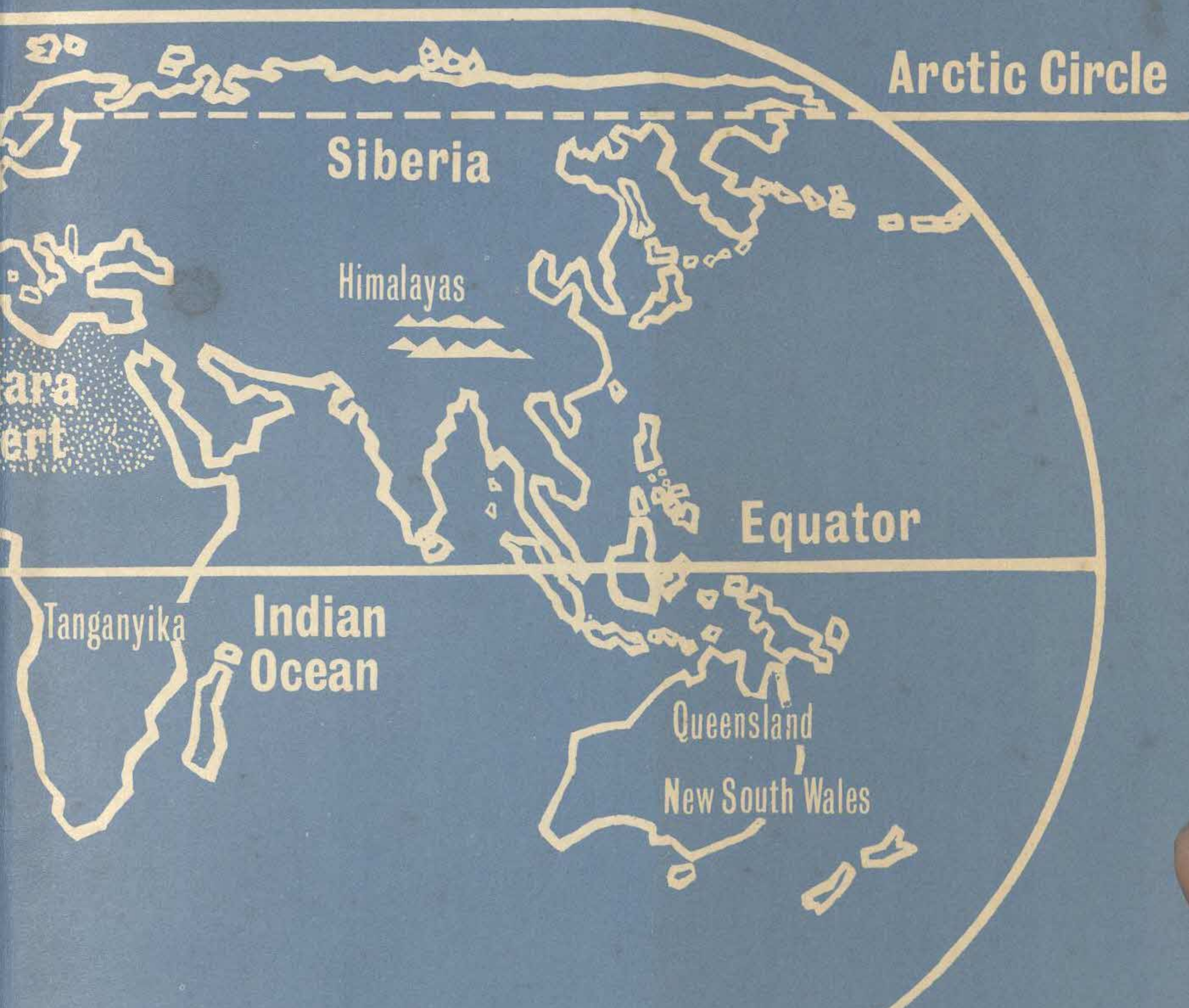

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MENTIONED IN THE TEXT OF THIS BOOK.
WAY OF SHOWING THE ROUND WORLD ON A FLAT PAPER.

MAN AND NATURE

By

PATRICK LYNCH

Illustrated by

JOHN LATHEY, M.S.I.A.

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PREFACE

This could be described as a Geography book for it tells about the world in which we live. When old men talk of their schooldays they tell us in their geography lessons they learned the names of all the capes and bays around the coast and the names of the world's most important rivers in order of length. They learned many facts about the world but these facts did not help them to understand how people lived or what problems they faced in earning their living.

Geography is such a wide subject that it really includes some Biology, Physics, Chemistry, Mathematics and History if it is to describe properly the world and its inhabitants.

This book tries to show how Earth's most successful inhabitant, Man, lives and the way in which he is affected by his surroundings, by weather, soil, plants and other animals. It also tells something of the way in which he has changed his surroundings and of some of the mistakes he has made.

If Man learns more about the world he will be less likely to repeat those mistakes and will be able to live more happily and more successfully in the future.

It is hoped that this book will encourage young people to learn more about their world.

A glossary at the end explains words which are spelt in capital letters in the text, and also serves as an index.

The illustrations in this book have been drawn with a great deal of care and for this I thank John Lathey.

P. B. L.

These Australian stockmen are doing what few people in the world can do today—they survey a vast area of land where no-one lives.

FAIR SHARES FOR ALL

'I am monarch of all I survey', the shipwrecked mariner is supposed to have sung as he sat alone on his desert island. He was for a time the possessor of a wide expanse of Earth's surface and there was no-one to dispute his claim. You probably consider yourselves much less fortunate for although you may, if you live in the country, share with your family a farm with fields around it, or a cottage garden; if you are a town dweller your kingdom may be no more than a back yard and a forecourt.

There are few people today who are the owners of all they can see and who can wander at will over hill and plain, through forest and moorland. Yet there was a time, about 9,000 or 10,000 years ago, when in the whole world there were probably only about 24 million people or half the number who now live in Great Britain alone. In those days Man lived on what he could get by hunting or by gathering wild fruits, and each person needed about eight square miles of grassland for himself if he was to find enough to eat. A small tribe of hunters would range over several square miles of land and would probably begin to feel that they were overcrowded if another tribe settled within sight of them! Today, as we look over the closely built houses of a town, along a crowded beach or down a busy road, we sometimes wish that we had a little more of Earth's surface to ourselves. It may not seem fair that the Australian sheep farmer should own 40,000 acres on which only a dozen people may live, whereas the same area of London contains about 5,000,000 people. The sheep farmer needs this vast area, however, for the grass of his land is poor and the sheep must be free to wander if they are to find enough food. Although he is not sharing his land with the Londoner he is sharing what his land produces, for the people of our crowded cities are wearing woollen clothes and eating mutton which the sheep have provided.

In a crowded city like Hong Kong people have no land which they can call their own, nor even much room to move about.
(Photo: Paul Popper Ltd.)

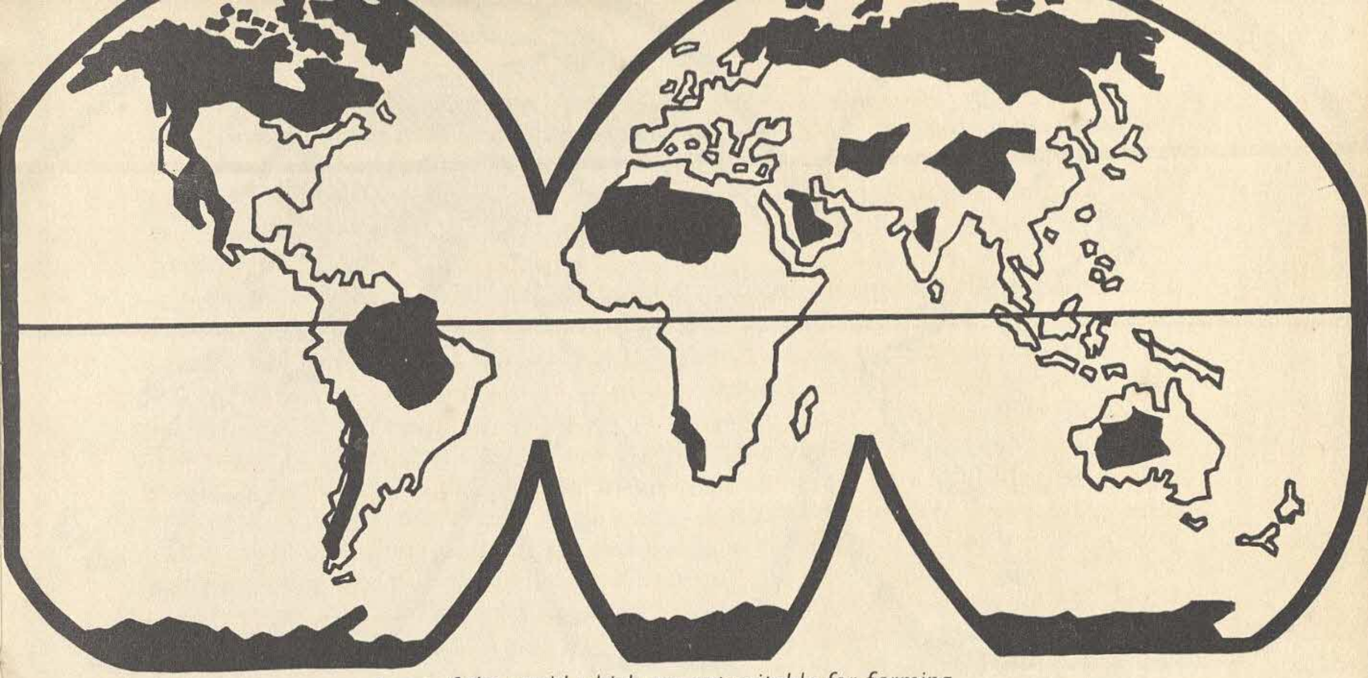
Because we have different jobs to do some of us only need for ourselves a few square yards of floor space in an office or a factory and the area on which our house is built; whereas others have to look after fields or forests or sail the seas in search of fish. We can not mark out the world into little plots and take one each, so those of us who live in towns have to be content with the little bit of land where we work or have our home.

Someone would soon take action against you should you decide to extend your frontiers to include the street or the public park at the back. Yet along with nearly 3,000,000,000 other inhabitants of the Earth you really own a much larger share in Earth's surface. Most of us know how big a football pitch is; try to imagine a field where there is room for dozens of games to be played at the same time. You alone own as much as 23 full sized football pitches and each member of your family, each of your friends has a similar empire. That is your share of Earth's surface but you will never be able to make use of it all, or even explore it all, for it does not lie all in one place but is scattered about the continents and oceans.

In the MIDDLE AGES in England, fields were divided into strips and each farmer had strips in different parts of the village so that everyone had a share of the good soil as well as a bit of stony ground or marsh land. From these scattered strips and from the common land where his pigs or sheep wandered, the MEDIAEVAL farmer made his living, for in those days not much was brought into the village from outside. It is because we today eat food and use materials which come from many different countries, and because there is no part of Earth's surface that Man could not reach if he wanted to, that we all may feel that we have a share in the world.

An area of Earth's surface equal to 23 football pitches for each man, woman and child would seem to be plenty, but we must remember that our shares are spread all over the world and that 5/7 of Earth's surface is sea.

Without the sea we would not be able to live, but we cannot live in it for we are land animals—not whales or fish. So each person's share of the world's living space is now reduced to an area as big as 6 football pitches, and these are broken up and spread about the world. Half of one of your pitches would have to be in Antarctica, covered always by a thousand feet of ice. Bits of other pitches would have to be in Greenland or Siberia, in the Sahara desert, high in the Himalaya mountains or in the thick, wet Amazon rain forest. You would have to take some moorland, some woods and meadows, some dry grass-land and a share of the regions where the soil is too poor and thin to grow crops. It is beginning to look as if we are rather short of space for only about 1/3 of the world's land surface is suitable for farming even if the most modern machinery and the best



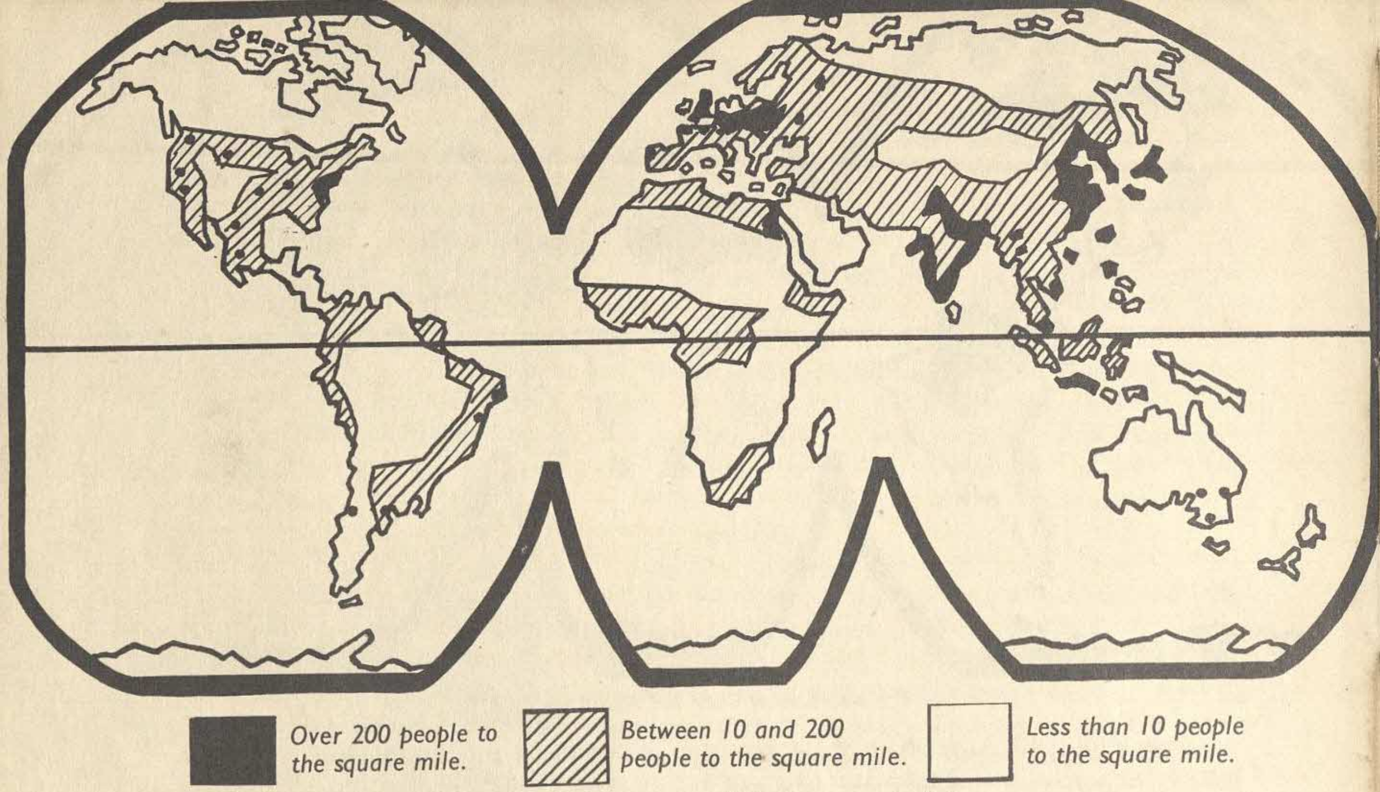
Areas of the world which are not suitable for farming.

methods were used. Your share of the farmland of the world is equal to about 2 football pitches, or 4 acres, and it takes just over one acre to grow enough food for the AVERAGE human being.

We cannot do anything to make our home bigger and there are no new lands waiting to be discovered as there were 500 years ago. We must make the best use of what we have and remember that there are now so many of us human beings on this little PLANET Earth that we cannot afford to waste any of our land or any of the food which the land produces. Man has been here for about 1 million years and during that time his numbers have doubled and doubled many times. We do not have any figures of course, but it is probable that there are 100 times as many people in the world today as there were a few thousand years ago. Man's numbers have increased because he has been successful in his struggle to make a living. The struggle still goes on, and will do as long as Man remains on Earth, but we must not think of it as a struggle against Nature. Man cannot make the winds and seas, the rain and sun do just what he wants, nor can he always decide what plants shall grow or which other animals shall share the world with him. What he has to do is to learn how to work with Nature and find out from her how he is to gain the most benefits from the land, the sea, the air, the soil and from the other living things around him.

THIS IS WHERE WE LIVE

'There are no dogs in Madagascar or Ceylon; there are no monkeys in Europe except on the rock of Gibraltar; elephants are only found in Africa and India' . . . These are some of the facts we would learn if a hard-working ZOOLOGIST was to make for us a series of world maps showing clearly where various types of animals lived in their *natural state.* Such maps would take no notice of the polar bears or lions which are found in zoos or of the husky dogs which explorers have taken to the Antarctic, for they would only be


■ Over 200 people to the square mile.
▨ Between 10 and 200 people to the square mile.
☐ Less than 10 people to the square mile.

The World, showing where most people live.

concerned with the animals as they were before Man interfered with them. Some of the rarer animals would have their homes shown by only a small patch of colour in Australia or in South America, but the map showing the parts of the world where rats live would be coloured nearly all over. That is because the rat is one of the most adaptable animals which has found that it can make a living for itself in places where other animals would starve. Spread even more widely over the face of the Earth is that very successful and adaptable animal—Man, who so often acts as an unwilling provider of food and shelter for the rat. We can also draw maps to show how human beings have spread themselves throughout the world and where they live close together as they do in England and Belgium, or India and Japan.

Most people live where their food grows or where their work is. Human beings have usually settled where it rains enough to supply them, their crops and animals with water; but not so much that they live in a swamp or in danger of flood. It is easier to live in the lowlands than high in the mountains, because it grows cold and the air becomes thin as one rises far above sea level.

Because of these things the parts of the world where most of us live are much more crowded than if the land surface of the Earth was shared out equally between everyone. Large areas of the world—in Antarctica, in Greenland and in the Sahara desert—are without people for in these places the climate is too EXTREME for people to live in comfort nor can food be found close at hand. So most of us come together and live within the boundaries which Nature has set, choosing particularly those places where there is a supply of water, where food is plentiful and easily won and where the climate does not make life too difficult to bear. People also live close together where supplies of coal or oil or iron have made it profitable to dig mines and build factories, in a position where other parts of the world may easily be reached by land, by river or by sea.

If Man was as other animals, depending upon his skin for warmth, his fangs or claws for weapons and tools, his feet or wings for transport and having only his INSTINCT to guide him, he would be forced to keep within Nature's boundaries, avoiding danger and famine as the monkey avoids the treeless plains, or the swallow flies from the northern winter.

Even without metal tools, machines and factory made clothes Man's brain and hands have enabled him to build a home and stay alive in an unfriendly land. By making igloos of snow and kayaks of skin the Eskimos can survive around the coasts of Greenland and Labrador; and by making a servant of the camel which carries him and gives him cloth for his tent, the Bedouin can make his living in the desert. The mountain farmers of Tibet were helped in their struggle for life by the hairy ox-like Yak; and the tough Indians of Tierra del Fuego, at the southern tip of South America, kept fires burning in their canoes as well as in their camps to give them some warmth in that cold, hard climate. Until recently all these people were making do with what was provided close at hand and were living near to the boundaries which Nature has set round Man's home.

But we are not satisfied with what can be picked up around us, nor are we content always to remain where life is safe and comfortable. Although the Age of BRONZE has passed and we no longer use copper mixed with tin for making axes, knives and pins, we still value it because it will not rust and use it for making pipes and electric wires. Nearly quarter of the world's supply of copper comes from Chile, from mines high in the Andes where miners work in conditions which would be unbearable for most of us who have passed our lives in the lowlands. Most men are unable to work at heights above 16,000 feet for the lack of oxygen in the thin mountain air causes sickness, headaches and sleeplessness. This 'soroche' or *mountain sickness* was also a severe handicap to the engineers

With materials found close at hand, and with goods bought from the white man's trading post, the Eskimo makes himself comfortable in the midst of his harsh surroundings.

High in the Andes Mountains stands this town which has been built for the miners who work in this uncomfortable region. (Photo: Hispanic Council)

who were building over the Andes mountains the Oroya Railway of Peru. Riveters found that they could work at such great heights only for about a week at a time and that frequent holidays lower down the line were necessary to their health. Passengers who are travelling on the railway sometimes have to call upon the train's doctor to administer oxygen if they are to come safely through the thin mountain air. Man has found it necessary to work in mines high up in the mountains and to cross from one side of the Andes to the other so he has gone beyond the invisible frontier which has been placed in the ATMOSPHERE about three miles above sea level.

Much of the wealth which Man seeks lies beneath the ground and often in places where few would otherwise go. The need for the MINERAL borax, which is used in many industries, led to the building of a railway through the maddening heat of California's Death Valley. Miners were able to work where nothing else could live but only because water and food were brought to them by supply train. In South America is another hot dry place, the Atacama Desert of Chile, where valuable NITRATES are found. It too is an inhospitable land and life in the mining towns is only possible because water is brought there by pipeline. All food, clothes and luxuries must be brought in by ship or by rail.

We have been using iron for a long while but the mineral URANIUM has only recently become important to us. Rich deposits of both have been found in the Arctic barrens and have drawn prospectors and miners to the far north of Canada and Labrador. The value of these minerals makes it worth while bringing in stores and engineering equipment by aeroplane and helicopter, and building railways at great expense through forest, and over swamp and river. In a land where only a few Eskimos lived their hard lives, modern mining engineers are bringing the conveniences and comforts of town life.

Scientists and army engineers have ventured even farther for they have found that their work may take them far inside the Arctic Circle. Eight hundred miles from the North Pole a town has been built beneath the surface of the Greenland ice cap. In snug, insulated buildings the men live beneath a roof of snow whilst outside the temperature will drop to 70 degrees below zero and blizzards will rage at 100 miles per hour. The heat, light and power of this buried town come from atomic energy, and many of the men may never go outside to see whether the sun is shining or whether it is the darkness of the Arctic winter. So, at great expense, and by using the gifts of modern science, Man shows that he cannot only live, but be comfortable where nothing else can live—far beyond the natural frontiers of his home.

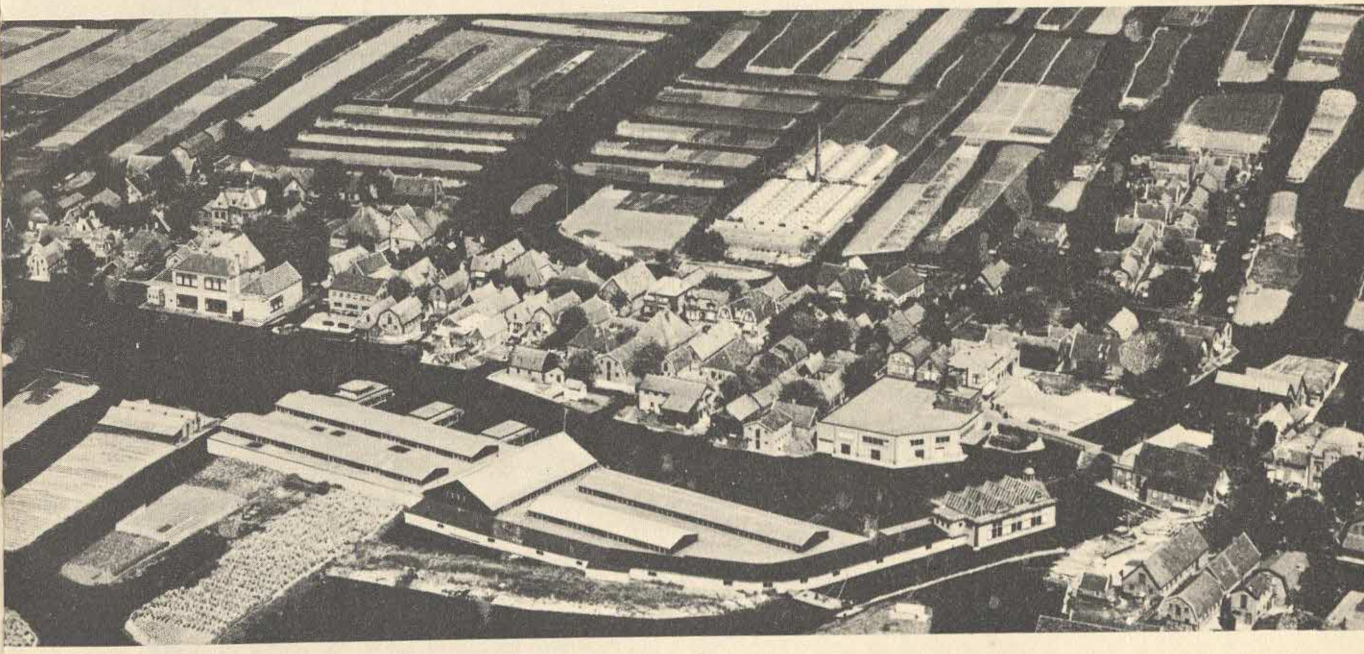
As knowledge has grown, as tools have improved and as thirst for information has increased, so Man has spread himself more widely throughout the world. More and more he is finding out and using those seemingly useless areas which occupy so much of the Earth's surface. Although we are land animals we should be glad that 5/7 of the world is covered by water for the sea provides many things which are necessary to us. Perhaps in the future we may even be grateful for the ice caps, mountain tops and jungles.

The shape of the Earth, the weather and the NATURAL VEGETATION have made the conditions under which we live. The way we live has been affected by our surroundings, but sometimes we do not accept conditions which Nature has made and we do what we can to change the things we do not like. The house you live in may affect you. If it has a low ceiling you may acquire a stoop, if it is dark you may strain your eyes, if it is dirty you may become ill. You cannot perhaps rebuild your house but you may be able to lower the floor, put in another window and clean the place thoroughly. We cannot rebuild our planet Earth but we are changing some of the details and affecting for good or for ill ourselves and the plants and animals which share our home with us.

THE WORK OF MAN'S HAND

Men with bulldozers, earth shifters and trucks have done less to alter the shape of the Earth than minute shelled creatures who lived in forgotten seas 100 million years ago.

These islands were once part of the sea bed. They are new farm lands given to Holland by Dutch engineers. (Photo: Aerofilms Ltd.)



When these lowly creatures died they sank and lay thick upon the sea bottom. The sea disappeared, the land lifted and the shell beds revealed themselves as chalk hills several hundred feet high. But the chalk makers had millions of years in which to alter the shape of their home whereas Man has only been making his mark for a few thousand years.

Man has neither built nor removed any mountains. He has only been able to change the face of Nature but not her bones, for although he has altered considerably the appearance of Earth he has changed its shape very little. Powers which Man cannot copy and which he can do very little to control may make more difference to the appearance of a place in a few hours than he could make in many years. A volcano may erupt and add several feet to its height as well as burying

A small wedge of concrete holds in check the waters of a lake hundreds of miles square. As the water rises islands are formed and later disappear.

surrounding villages under a layer of dust and LAVA. It is only when Man is at his most destructive, when he has released the terrible power contained in an atomic bomb, that he can come anywhere near to the power displayed by a volcanic eruption. Fortunately Nature is not often as violent as when the volcanic Mount Pelée devastated the Caribbean city of St. Pierre and killed 30,000 people on the night of 8th May 1902.

Water, which looks so gentle and harmless when it laps on the lake shore or flows as a peaceful river through the meadows, may be turned by wind and tide into the destructive giant which gnawed away 40 foot cliffs on the Lincolnshire coast during the storms of January and February 1953.

Man cannot prevent the volcano or the earthquake and he may be forced to run away and abandon his farms as the unfortunate islanders of Tristan da Cunha did when their sleeping volcano woke up in 1961.

The storm waves cannot be prevented from rising either and it is a difficult and expensive task to build walls which will keep a high sea from flooding over a low lying coast. When Man battles against Nature he usually finds out what a feeble creature he is, but when he works with Nature he often has good reason to feel proud of what he has done. Against the sea the best defence is not hard, unyielding concrete but dunes of soft, yielding sand bound together and strengthened with *marram* grass, which originally grew wild but now is often planted by Man to do what his steel and concrete can not do.

When Nature shows the way or completes his work for him Man is able to make the greatest changes to Earth's face. Certain areas of Holland now bear the names of Flevoland, Markerwaard and Lake Yssel. Once they were all part of an inland sea called the Zuyder Zee and fish swam over what are now hayfields. Nature provided a shallow, silt-choked sea and gave it a narrow mouth. Dutch engineers improved the position. The Great Dyke, nearly 17 miles long, was built across the entrance of the Zuyder Zee. Other dykes were built around shallow areas and the POLDERS thus formed were drained by a network of canals and pumped dry. As the water disappeared and the floor of the polders came to light the remains of old ships were sometimes found to remind the engineers that the sea which they were mopping up had a history of hundreds of years. Now along the tops of the dykes Dutchmen's cars speed along—running as straight as the ships which they have replaced. The work of draining is not yet complete but already several hundred square miles, the area of a small county, have been added to the farmlands of Holland. Thanks to their own efforts over a period of little more than 30 years the Dutch have made it necessary to draw new maps of their country.

Around the Wash, on the Lincolnshire and Norfolk coasts, salt marshes have been forming from silt dropped by the ebbing tide. If left alone the marsh might remain for ages, neither land nor sea but a place where grow only those grasses which can thrive in salty water, the home of shell fish and sea birds. Very slowly grasses and trees from the land might invade the higher mud banks where the sea could no longer reach. But Man has stepped in to speed up the process and, enclosing a little at a time, has built walls between marsh and sea and dug ditches to drain away the salt water. Sometimes help has been given by Dutch engineers who have learned by experience the best ways of draining and reclaiming land. Once the sea has been prevented from washing over the marsh, Nature is allowed to help again, for rain washes out the salt from the mud so that, instead of the salt resistant rice-grass and sea couch-grass, field grasses may be planted. On England's east coast the work has been going on since Roman times, and during the last

300 years about 50,000 acres of land have been won from the marshes.

You cannot push a heavy truck along a road, but once it is moving you are able to guide it by a very light turn of the steering wheel. Man cannot easily build up land but he can guide Nature and persuade her to do it for him. So the people of ancient MESOPOTAMIA (modern Iraq) encouraged their rivers to lay some of the mud they were carrying down upon bundles and mats of reeds which were placed in the water. Little islands appeared and joined together so that new land was formed. Drains were dug and kept clear of mud, and other channels were made to lead water to the thirsty desert. On the fertile land thus created, generous crops of corn were grown which caused the peoples of the neighbouring lands to look with envy upon the full granaries and smiling fields of the *land of the rivers*. Man's hand only guided the water, for without his interference the river would still have dropped its mud and formed marshland, but when the ditches and drains were neglected Nature went her own way again like a truck when the driver forgets to steer. The distant fields, once IRRIGATED and fruitful, became desert again and the river once more wandered at will through the marshland. In the marshes mosquitos bred and spread MALARIA. The disease made people weak and prevented them from doing the work necessary to drain the marshes; so the marshes caused more disease and a *vicious circle* was started which has only recently been broken. The task of reclaiming the marshes began with a battle against malaria and now the people of modern Iraq are busy making up for the neglect of centuries and are again guiding the water to where it will do most good.

Considering the difference it makes to the appearance of Earth's surface, water is fairly easy to control. A river cannot be prevented from flowing but it may be tamed and guided. A dam placed across a river valley may be only a few hundred feet wide and high but it can turn that valley into a huge lake.

The Kariba dam, which is a wedge of concrete 420 feet high and 1,900 feet wide across the top, blocks the river Zambesi as it flows through a narrow GORGE. For three years the water rose behind the dam, climbing the river banks, filling the gorge and smaller valleys, and surrounding bits of slightly higher ground to make islands which gradually grew smaller and finally disappeared. Now the lake is full and the comparatively small wedge of concrete is responsible for a sheet of water 170 miles long and in places 20 miles wide—one of the largest man-made lakes in the world, covering an area as large as Lancashire or Norfolk.

The Kariba Dam was built to provide a fall of water which would turn dynamos and generate electric power for Rhodesia. Rhodesian people are receiving benefits from the dam, but 30,000 people of the Batonga tribe have had to move to new homes, and thousands of wild animals have also been affected. Their homes have been destroyed, many have been drowned and many more would have died if a small band of game wardens and their willing helpers had not carried out 'Operation Noah', a campaign in which many different animals were rescued from the small islands which were made and then threatened by the rising waters. Of course the animals did not appreciate what was being done for them and many struggled violently to escape from the ropes and nets which were used to catch and hold them. But the rescuers bravely carried on with the work and, because they believed that Man had already done enough to upset the *balance of Nature*, they did not refuse to help any animal however dangerous or unpleasant it might seem to be.

In the U.S.A. the whole valley of the Tennessee River has been changed by a series of dams which form a chain of lakes and provide a waterway 600 miles long. The weight of falling water as it is led through the dams supplies electric power, and the dams also are designed to hold in check the floods which every spring used to threaten the valley. No longer do the people of the Tennessee Valley fear the spring rain lest the river wash away their barns and chicken coops or maroon their families on the farmhouse roof. By opening or closing SLUICES the level of the lake water can be lowered or raised, and the flood waters can be allowed to escape gradually as first one lake, and then another is filled to its highest mark. Even when there is no danger of flood the level of the water is continually being raised or lowered so that the LARVAE of the ANOPHELES mosquito, lying on the lake surface, are flooded and drowned and fewer of them survive to become carriers of MALARIA. Thus, by altering the surface level of his artificial lakes, Man not only changes the appearance of the countryside; he also affects the living creatures who live nearby.

You can change your clothes and still remain the same underneath, but Earth cannot. Plants are more than cover; they are a part of Earth's surface. Too often Man has said, 'There are trees; I will cut and burn them and in their place grow corn'. But trees do more than dress the hills in a coat of green; they hold back and use the water soaking through the ground beneath them. Rain falling on a forest-covered hill-side will drain away gradually, whereas a cloud-burst over a bare hill-side might cause a sudden flood, and the water racing down the slopes would take with it the precious soil of the farmer's fields. In the Tennessee Valley the pioneers cut down their hill-side forests and Nature punished them by washing away their cornfields and leaving their land scarred and bare. Besides building dams the T.V.A. planted trees and recovered the naked hills. So twice within 150 years Man has changed the face of this corner of the U.S.A. The second change is one for the better, for now Man is learning that if he is to prosper he must keep the rules which Nature has made.

Sometimes, because he has not simply taken the quick and easy way of changing the face of the land, but has worked slowly and patiently for hundreds of years, Man has been

Like stairways to the sky the rice fields of the Philippines climb the sides of hills. (Aerofilms Ltd.)

able to transform a wild and seemingly useless region into fertile farmland. The Bontok Valley lies in the heart of a mountain range on the island of Luzon in the Philippines. Here the mountain sides have been cut into terraces which lie one above the other and rise for hundreds of feet above the valley floor like a giant's stairway. Each terrace is a tiny rice-field which is prevented from sliding down the mountain side by a skilfully made stone wall. In all there are 15,000 miles of walls and the hill-side fields have an area which adds up to 150 square miles. Rice grows best when it is standing in water so each field is a pool in which fish are sometimes reared. Through bamboo pipes water is led from the topmost terraces to the ones below and the good soil, which produced crops as heavy as one ton of rice from every acre, is left safely behind the wall instead of being allowed to wash away down the hillsides. The natives who built these silver and green stairways did not have any modern scientific training but they studied the rainfall and the shape of the hill-sides, and made sure that they did nothing which Nature would destroy or which would prove harmful to the land. They need to work hard to keep their walls and terraces in good condition but, since their ancestors have been showing them the way for 2,000 years it is not likely that they will easily forget the lesson that those who shape the land need to be patient and to take trouble.

There is an old saying, 'God made the country but Man made the town', which is not strictly true. Although Man is responsible for the ugliness or charm of cities and towns, the countryside is, in very few places, as Nature left it. From the prehistoric LYNCHETS looking like steps carved on the chalk hill-sides of England, to the 20th century motorway slashing across the countryside, the work of Man is seen everywhere. The very fields of our countryside are the work of Man for many of our ploughed fields were once forest, and even the hedges where grow the wild flowers and where live nesting birds, were laid out by farmers.

We human beings are puny creatures and have not ruled the Earth for long, but if some sudden plague killed us all overnight it would be a long while before the signs of our stay here were rubbed out. Even if, in a thousand years, all buildings, roads and dams had fallen to pieces and were hidden; if all quarries, cuttings, tunnels and mines had collapsed and were overgrown, still the world would not be the same as it was before Man came; for once forests have been cut and burned the original trees do not always come back; the soil would be different in the river valleys behind the fallen dams, and not all the land won from the sea would lie again beneath the waves.

THE CHANGING AIR

When we find ourselves alone with strangers for any length of time, in a waiting room, a train or a queue, we begin to talk; and we generally talk about the weather. There are other subjects in which we can be sure that most people will take an interest—the day's news or last night's television programme—but the weather nearly always starts the conversation. This because the weather is one of the four things that affect our homes, our jobs and our way of living.

The type of home a man needs, the way in which he produces his food—whether by growing crops or by keeping cattle; and the clothes which he needs to wear, vary from place to place about the world for, as we have seen, Man is *adaptable* and can live happily

These houses in St. Louis, Missouri, have been damaged by a hurricane—not by an explosion. (Photo: Keystone Press Ltd.)

in many different conditions. Plants and animals, however, are much more easily affected by their surroundings; and the type of plant which grows, or what sort of animal lives in a certain place—or indeed whether anything lives at all—depends upon the same four things. The first is its position on Earth's surface—whether it be near the equator or one of the poles. The second is the type of rocks which lie beneath it—whether they be sand, clay or granite. The third is the shape of the land—whether it be hill, valley or plain; and the fourth is the *weather*—whether it be raining, snowing, blowing a gale or foggy—or each by turn.

The first three of these conditions do not alter from day to day but the weather does, and in doing so alters our surroundings as much as would a move to the north or south or an upheaval of the rocks. It is because it changes so frequently that the weather is interesting to us. An Arabian camel driver, queueing to use a water trough, would not be likely to say, 'A hot day, isn't it?' to the man standing by him; nor would a native of the thick, wet Amazon forest remark on the heavy rain which they had received during the night! For both of them the weather changes little from day to day and seldom gives them cause for excitement or despair.

Amongst us, however, live many whose fortunes depend upon the weather and who may be ruined if it behaves in unexpected ways. A frost in the late spring may kill the blossoms of orchard trees and so destroy the fruit harvest. A long dry summer will send up the prices of vegetables in greengrocers' shops, and a wet autumn may prevent the farmer from digging up his potato crop. Heavy falls of snow can cut off remote villages from food supplies and hospitals, and heavy spring rains may sometimes make rivers overflow and flood low lying houses.

Such accidents happen to people in Britain, a land fortunate—even though its people may grumble—in having a mild and pleasant climate. It can be very much worse in places where the weather is less TEMPERATE. Those who live on the shores of the Gulf of Mexico, in Texas, Louisiana and Florida, are frequently the victims of hurricanes, called by such innocent names as *Carla* or *Debbie*, but which bring terror as they whirl inland from the Caribbean Sea, sweeping 40 foot waves over sea walls to cause floods in coastal towns, uprooting trees and flattening houses.

In recent years a great deal has been discovered about hurricanes—how they are caused, the patterns made by the violently moving air within them and the direction which they are likely to take. A hurricane is a great wind revolving rapidly and rising in a mighty spiral. Its centre is an area of calm known as the 'eye', but anyone who finds himself in the eye of a hurricane has no reason to congratulate himself on his fortunate escape, for the whole whirling mass of air is also moving along a curved path; and a place which at one moment lies calmly in the eye will the next moment find itself lashed by a furious wind.

Pilots have bravely flown their planes over the whirling masses of air and down into the hurricane's eye to photograph the clouds and to make reports on what is happening.

Now hurricanes may be spotted before they arrive. A satellite, making ORBITS which pass over the Caribbean Sea contains television cameras which are able to transmit pictures to watchers on the ground. An observer of the U.S. Weather Bureau sees on a screen the signs of a hurricane—a dark spiral of clouds covering a distant part of the sea. The next time the satellite passes over, it will show how the young hurricane has moved and from this it is possible to tell approximately where and when it will reach the coast. Once it has been recognised, the approaching hurricane can be tracked by radar so that minute by minute its path and speed can be marked on a map. Those people who are living in the area where it is likely to strike can be given several hours' notice of the danger. They may then leave homes and farms to their fate and seek safety by joining the stream of cars and buses moving inland. When the hurricane *Carla* struck Texas in September 1961 very few people were killed, but millions of pounds worth of damage was done to buildings and crops.

A close relative of the hurricane is the typhoon of the China Seas. In 1922 a typhoon passed over the Chinese town of Swatow, bringing with it a huge wave which swept 50,000 people to their deaths. If the Chinese had been able to foretell the approach of that typhoon their homes would still have been destroyed but thousands would have been saved from drowning.

KEEPING A WEATHER EYE OPEN

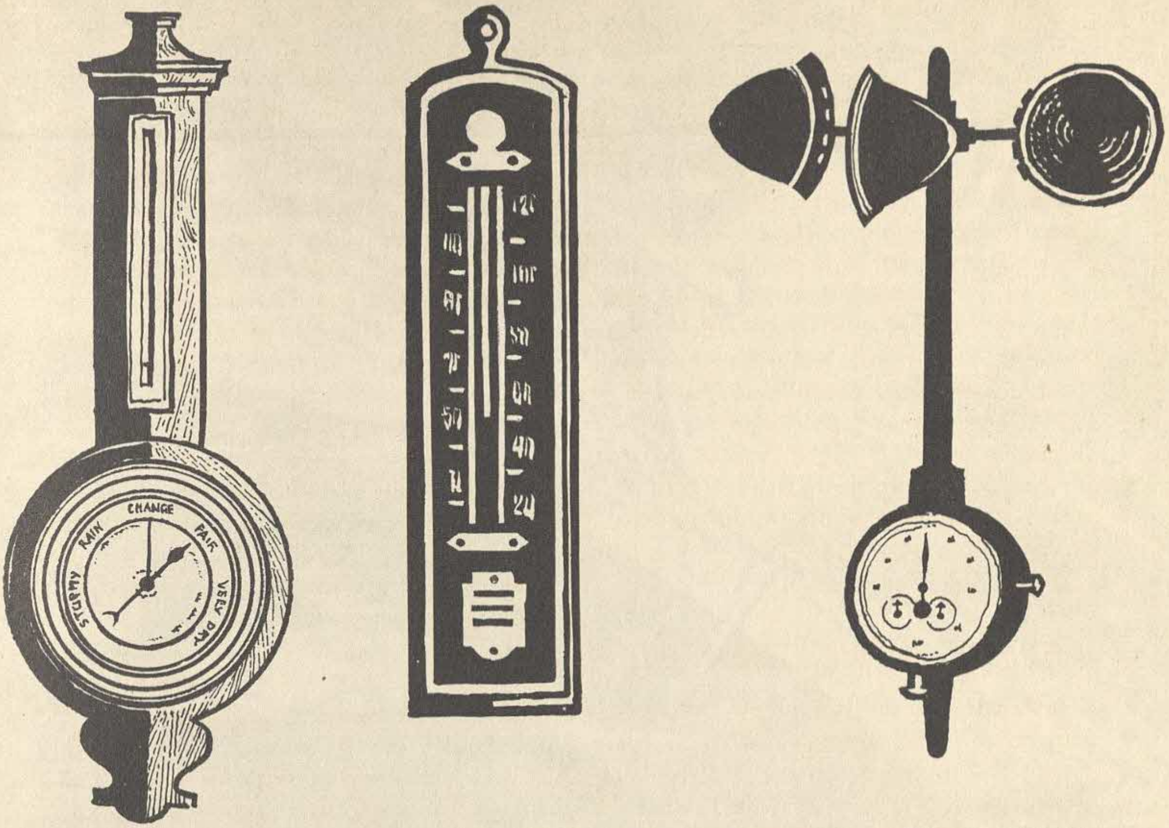
The weather is most dangerous when it does something sudden and unexpected, but it can be annoying and its results may prove expensive if it merely behaves in an unusual manner. Torrential rain may fall on land which has been dry for years, or a region of grassland or cornfields may suffer drought so that crops fail or cattle die. Of course the risk is made less if it can be foreseen and some of Man's oldest wisdom is concerned with what will come from the sky tomorrow. Sailors and fishermen, farmers and shepherds whose work keeps them out of doors, and who depend for their living upon the weather, noticed the appearance of the sun, the moon or the sky and made discoveries which they often put into rhyme. Some of their sayings we still repeat today but perhaps wonder whether we should believe them.

'A red sky at night is the shepherd's delight' means that the next day should bring good weather. A METEOROLOGIST would tell us that this is true for the red colour is caused by the red rays of light from the sun being able to pass through the ATMOSPHERE in which particles of dust and soot are floating. For the minute specks to be able to become plentiful, the air must be calm; and calm air usually means that the fine weather will continue.

Another old country rhyme says:

'If the moon show a silver shield,
Be not afraid to reap your field;
But if she rises haloed round,
Soon we'll tread on deluged ground.'

The 'silver shield' of the moon in a clear cloudless sky does point to fine weather which would be suitable for gathering the harvest, whereas if the moon has a halo there must be something in the atmosphere which is scattering the light. There is no pane of frosted glass over the moon but the same effect is given by tiny ice crystals which cause rain drops to form and to fall to the ground. Although most of the old countryman's sayings



These are the weatherman's instruments—the barometer, the thermometer and the anemometer.

have a great deal of truth in them others are merely absurd. Some folk point to a holly bush which carries a load of berries and say that it will be a hard winter as the holly is providing for the hungry birds. How the holly bush is supposed to know what is coming, and why it is so kind, they will not say; neither can they explain why the next holly bush down the road has no berries! The only thing the berries on a bush could tell us about the weather is that the previous summer was a good one—for holly bushes at least!

Although Man has been building up a store of weather wisdom ever since the days of the first shepherd and the first farmer he now realises that he is only beginning to learn how to forecast the weather. The METEOROLOGIST is a scientist but, whereas most scientists can watch their experiments in laboratories and can even repeat them, the meteorologist watches what is happening over 200 million square miles, in a layer of air over 30 miles thick. The conditions are changing all the while and he cannot go back and have a second look at what was happening yesterday. He depends upon reports sent in every hour by radio from hundreds of weather stations and ships all over the world. When information from several weather stations is marked on a map the trained eye of the weather expert is able to estimate which way air currents will move and whether they are likely to bring with them fine weather or wet. To help him make use of all the information constantly pouring into his office the meteorologist has electronic computers to do his sums for him. If he was to work everything out with pencil and paper he would not have his forecasts ready in time for them to be of any use. It might in fact take a month of paper work to produce a forecast, which was to tell the waiting farmer and fisherman

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of weather which was expected only a day ahead. It would not be much comfort to a farmer as he looked over his soggy fields to learn that almost a month ago he could have expected rain!

The man who makes the observations and supplies the facts has simple instruments but they have to be carefully used. He has to find out whether the air is warm or cold, wet or dry, how heavy it is, which way it is moving and at what speed it is going. The THERMOMETER tells the temperature of the air, but so that it will not give too high a reading it is shielded from the rays of the sun. That is why weather reports state that a certain place had a temperature of so many degrees 'in the shade'. A BAROMETER measures the *pressure* or weight of the air. Up a high mountain or in a high flying aeroplane there is less air above you than there is at sea level. The pressure will therefore be less and the barometer will give a lower reading. Its behaviour also varies according to the temperature of the air and the part of Earth's surface where it is being used so, if a METEOROLOGIST is to use a barometer properly, he must understand and allow for these complications. Even without understanding its behaviour fully many people use a barometer as a rough guide to the weather. They know that if the mercury in its tube falls, the pressure of the air is falling too and that this usually means the weather will change for the worse.

Also amongst the weather man's instruments is a pair of thermometers, one appearing quite ordinary and one with its bulb clothed in a sleeve of wet muslin. These thermometers will give different readings and, by finding what the difference is between the two figures and consulting tables, the observer can tell exactly how damp the air is.

Wind is moving air and it is necessary to tell the direction and speed at which the air is travelling. An accurate and freely moving weather vane does the first job as long as it stands clear of buildings and trees which make the wind twist and turn in many different directions. The speed of the wind is shown by an ANEMOMETER which can be a complicated and delicate instrument of tubes or thin wires, but more often consists of four cups set at the end of rods which spin ever faster as the wind increases. The force of the wind is measured by the *Beaufort Scale* which ranges from the calm of Force 0 when a wind of less than one mile per hour allows smoke to rise vertically and the sea to be mirror smooth, to the terrors of a Force 12 hurricane. Then winds whirl by at over 75 miles per hour, laying waste the countryside, destroying buildings and piling the sea up into spray-streaked waves high enough to hide ships in their troughs.

But modern Man does not work only on the ground nor is the state of the air at ground level enough to show what is going to happen to tomorrow's weather. Pilots of high flying aircraft want to know what is likely to happen several miles above the Earth, and as more is discovered about the upper ATMOSPHERE it is seen that its movements affect the weather near the ground.

The meteorologist cannot however take his ordinary, clumsy instruments into the upper air and study them so he makes use of the information sent to him by *radio-sonde balloons*. Unfortunately, as these are expensive and elaborate devices and as not many are recovered after making their long voyages, only a small number can be released and a limited amount of information collected. The balloon itself is a bag made of a plastic sheeting filled with hydrogen. Attached to the balloon is a radio transmitter which sends out a recognisable signal. When followed by two radio receivers on the ground its height,

A satellite may carry cameras which tell the meteorologist what is happening in the atmosphere.

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distance and speed can be worked out. So it shows directly the speed and direction of the air currents upon which it rides. More than this it can do, for linked to the radio are sensitive instruments which are affected by air pressure, by heat and by HUMIDITY. As these instruments react they take it in turns to alter the strength of the current being sent through the radio and cause it to change its pattern of dots or pips. As the signals come through to the receiving stations their meaning may not be immediately understood, but they are recorded on a teleprinter tape and, within an hour or two, experts can read the dots and translate them back into figures which show the various states of the air during the whole of the balloon's flight. Another type of balloon—the *rawinsonde* has a small target or reflector attached to it so that its course may be tracked by radar.

Not only would we like to know what tomorrow's weather will be, but before planning our holidays we wonder whether we will have a fine summer or not, and farmers and builders would be very interested to learn six months ahead what sort of winter to expect.

Many attempts have been made to find a pattern in the weather. Sometimes superstitious people have tried to see one because of some strange happening in the past. Because it rained once on 15th July, when the monks of Winchester tried to bring the body of St. Swithin from a grave in the churchyard to a tomb in the Cathedral, and on that occasion it continued to rain for 40 days, the belief grew up that if it rained on St. Swithin's Day it would continue to rain until 24th August. Modern students of the weather are much more scientific and they have to be very careful that they do not make rules about the future because of a few coincidences.

The amount of ice in the Arctic Ocean in December affects the temperature of the sea and, as it melts, cools the sea's south-flowing currents. The temperature of the air is affected too and, because changes in the weather are linked one to another as if by a chain, the ice of 3,000 miles away makes a difference to the amount of rain falling in the spring on Britain, France and Holland. There seems too to be a connection between the amount of rain falling in Java in October and the weather in Bombay six months later.

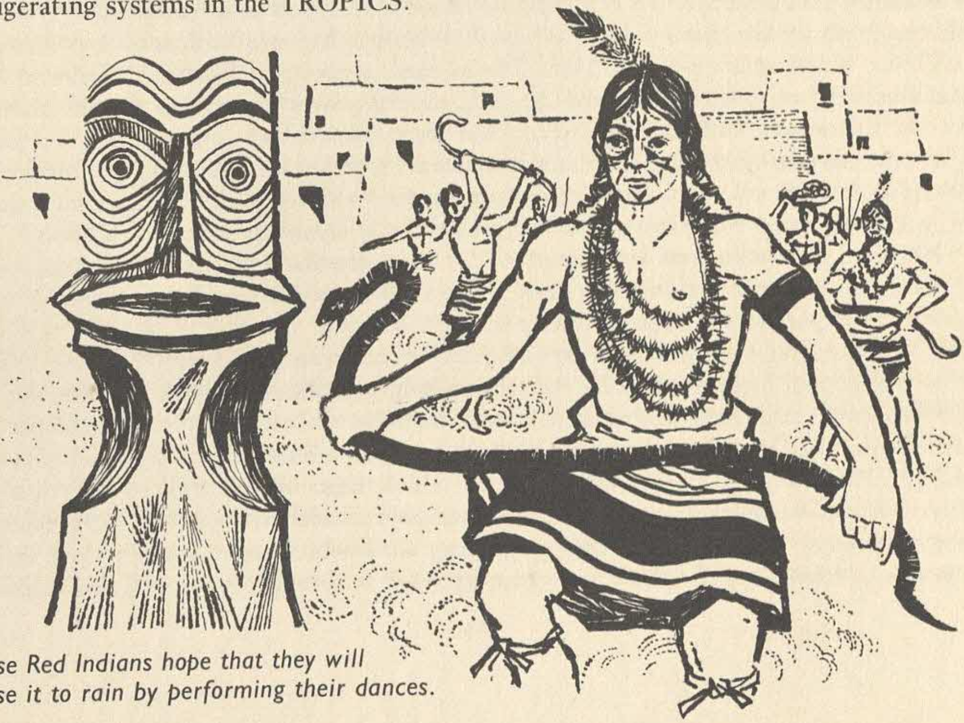
Before any firm rules can be made, however, dozens of charts and records have to be studied over a period of years. The meteorologist has to be sure that he is looking for the right things in the right places. He may believe that he sees a connection between the temperature at A in January and the rainfall at B in March, but if he was to study the conditions at X—a place hundreds of miles away whose charts he has not even glanced at yet—he might see that what they told him would help him to understand much more clearly the reasons for B's heavy rainfall! The pattern of the weather is difficult to see clearly because it contains so many complicated smaller patterns made by the moving air, moving water and a spinning Earth.

Whilst one meteorologist studies the weather at different places throughout the world, another studies the weather's history. He may find that the rainfall and temperature charts of the present are very like those of a previous year. He will compare the two sets of charts day by day and week by week, and try to find other years when there was a similar pattern. He will try to find out why these years were wet or cold and he may be able to gather enough evidence to make him suggest that the weather for the following six months will be like that which followed in the years he has been studying. At present few people would care to rely upon such long range forecasts and it would be a rather foolish person who refused to buy coal for his house because he had heard that it was going to be a mild winter. A German meteorologist who has made a careful study of the weather in Europe over many years has sometimes been successful in making forecasts for six months ahead, but he does not pretend to be able to tell exactly what will happen.

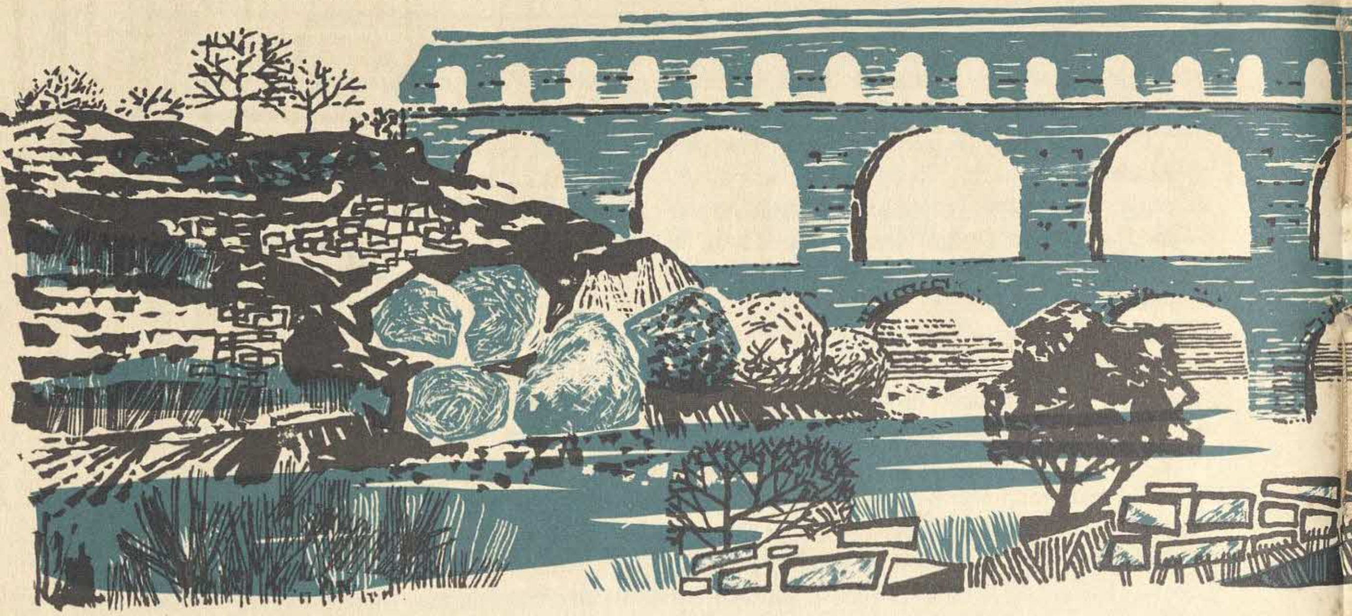
Even more than trying to forecast the weather would Man like to change it when it threatens to harm his crops. In some parts of the world heavy hailstorms can do great damage, but sharp-eyed weather watchers in France have picked out certain clouds which seemed as if they might form hail. Then, by making a series of explosions within the cloud, they caused it to CONDENSE quickly and fall as rain which would not harm the delicate ripening grapes.

Many primitive tribes perform dances and ceremonies which they feel sure will cause the rain-god to be kind to them and their parched fields. Modern rainmakers realise that there is no chance of causing rain to fall if there is no cloud in the sky. Since rain drops form most easily when water can gather round a speck of dust or ice, the rainmaker tries to supply the cloud with what it needs. From an aeroplane a chosen cloud is *seeded* with minute particles of 'dry ice' (frozen carbon dioxide) or silver iodide crystals (which resemble ice crystals) or even with water from a very fine spray. Sometimes this process has worked and the clouds have dropped their rain, but the rain makers can seldom be sure that the rain would not have fallen even without their help. It is, moreover, rather risky to interfere with Nature. No one can sue a cloud for damages but people who are giving a garden party or organising a big cricket match would be very annoyed if some men in an aeroplane caused a cloudburst right over their heads. It is difficult to please everybody!

Rather than hope that he is going to be able to change the world's weather Man must continue to learn how to live with it. Gradually he will discover the secrets of the changing air, his weather forecasts will become more reliable and he may even be able to foresee the weather for years to come. He will improve his methods of storing and draining water so that farmers will be less at the mercy of the rain; he will experiment with plants and animals until he finds varieties which will live where formerly it was either too cold or too dry, and he will use his new atomic power to bring warmth to the Arctic or to work refrigerating systems in the TROPICS.



These Red Indians hope that they will cause it to rain by performing their dances.



WATER AND LIFE

A family went on a camping holiday. Each evening when they arrived at a camp site the jobs were shared in the same way; the father made ready the tent, the mother lit the stove and started preparing supper and the child was sent off with two cans to find a tap or pump and bring back water. In this way at least one of the campers formed the opinion that water plays far too large a part in the lives of human beings! It is only when we are deprived of our kitchen sinks and bathrooms that most of us realise just how valuable water is, yet the water which we drink or with which we wash ourselves is only a small part of the water used by Man. The farmer needs it for his fields, factories need it for washing raw materials and dyeing cloth, atomic power stations need it for turbines, and oil refineries use vast quantities to cool the hot gases which make petrol.

It is not surprising then that certain industries are found on the banks of rivers where there is a plentiful supply of water and where barges and tankers can unload their cargoes. But not always can Man choose to live where sufficient water is easily obtained. Nor can he afford, if he is to grow sufficient food for a hungry world, to neglect the lands where the rainfall is too small for crops to grow. In some parts of the world the search for water is far more important than the search for oil, coal or gold.

In some areas of California the rainfall is slight and water is scarce. Ordinary shallow wells, which were kept supplied by the rain soaking into the rocks lying near the surface, were unable to keep pace with the demands made by the extravagant Californians. Far beneath the surface, in layers of POROUS rock which lie sandwiched between IMPERVIOUS layers, are pockets of water which were buried millions of years ago. They had lain undisturbed since some ancient upheaval of Earth's surface covered them, but recently they have been reached by the deep wells which water engineers are drilling in search of fresh supplies. Now 20th century Man is drinking water which has lain in

To bring water to the Provençal city of Nimes the Romans built a long canal which crosses a valley on this great aqueduct—the Pont du Gard.

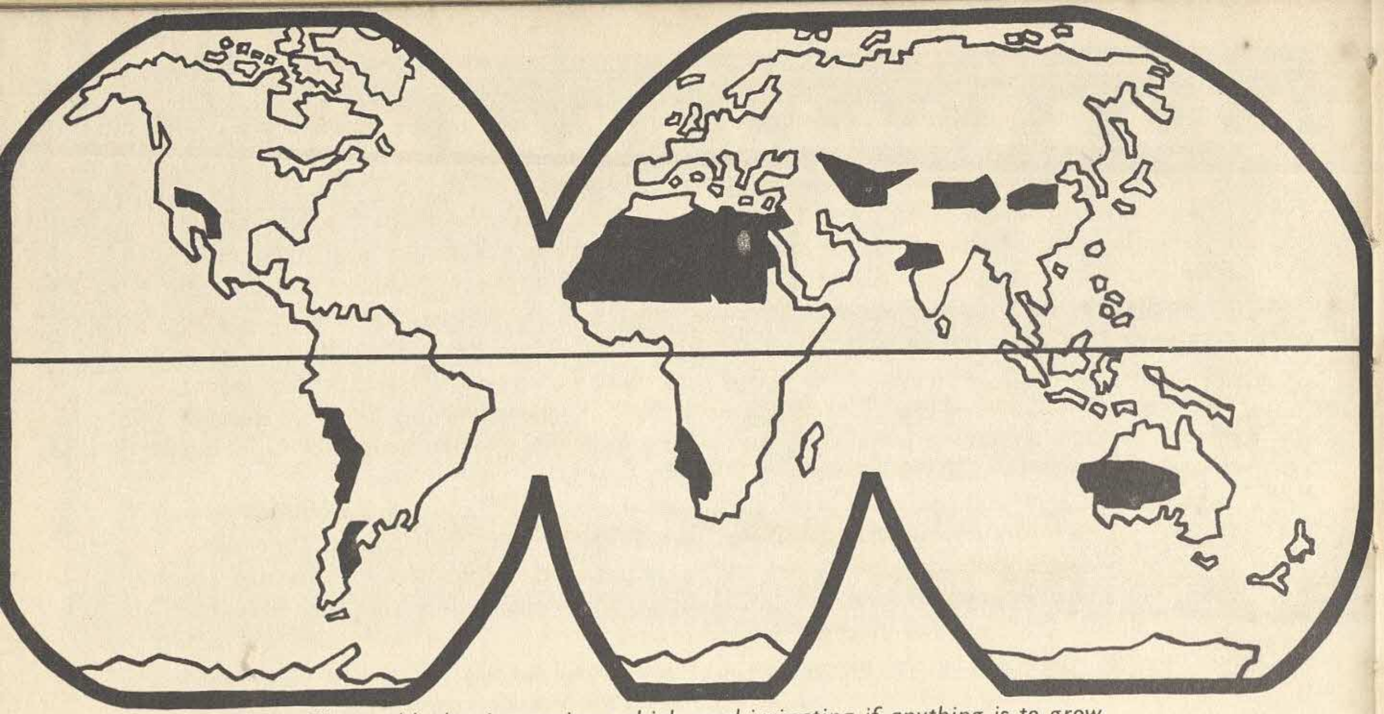
the dark since it fell as rain upon a world where no men had yet lived. We could say that this water is being 'mined' as if it was a MINERAL for, just as a coal or a gold mine may in time become worked out so one day will these underground sponges become empty and some other method of obtaining water will have to be tried.

Water is so precious that to search and care for it has provided many a man with a full time job. 5,000 years ago Persian miners were digging *qanaats*—underground canals which run 20 or 30 miles from the mountain springs to the farmlands of the dry plains. The modern civil engineer does not need to go to such trouble for he can lay metal pipes which will not leak or become choked with sand. Instead of digging, as the Persians did, he uses his new knowledge and equipment to search for water deep in the ground, reaching with his drill places where the spades of the ancients could not hope to go.

There is more water hidden beneath the ground than most of us realise. To rain water falling on the land four things can happen: some *evaporates* and returns to the air: some *runs off* and goes to make a rivulet, a brook and, in time, a river; some soaks into the soil and is *absorbed* by the roots of plants, and the rest *soaks* into the rocks out of sight and beyond the reach of plants or thirsty animals. The hidden water may find its way into underground streams which later make their appearance at the surface, it may filter through the rocks and bubble out as a spring or it may collect in a great underground reservoir of POROUS rock.

The water engineer makes it his business to study the way in which different types of rock lie upon each other. His knowledge of GEOLOGY and the tests which he makes will tell him where underground water is likely to be found. He will then drill into Earth's crust a well which may be 600 or even 6,000 feet (more than a mile) deep.

Once the city of Quito, the capital of Ecuador, high in the Andes mountains, depended for its water supply upon a trickle from a filthy germ-laden reservoir. Many people had to buy water from street sellers who carried it in jars on their backs. A water engineer came and studied the rocks of the mountains, the snow which lay upon them and the



The world, showing regions which need irrigating if anything is to grow.

streams which flowed down their sides. He bored eight wells into a natural reservoir 600 feet below the surface, and from them he was able to provide the city with eight million gallons of fresh, pure water each day. Soon even poor people had taps in their homes, the city became cleaner and typhoid, a terrible disease which can be carried by water, was almost wiped out. In India, Iraq, Libya and many other parts of the world, where the rainfall is low or unreliable, deep wells have been able to bring water to parched fields and thirsty villages.

After hearing a story like this we might think that people who need water have only to send for an engineer with his drilling rig and GEOLOGICAL maps, and that soon he will provide them with all they need. But it is not always quite so simple. If water is pumped up from underground there will be so much less in the hidden reservoir and the WATER TABLE may fall. Where two or three villages or farms are sharing the same water supply, a new well taking out several million gallons a day for the benefit of a nearby town, could cause the level of underground water to sink. A hill farmer might then find that the well which had supplied water for his cattle and sheep was drying up. Even though this poor farmer made his well deeper he would find no water for he would be drilling into the clay which previously had formed a sort of waterproof dish in which the water-bearing rocks were resting. Even the farmers of the valley might find that their land was drier than it had been and that their water-meadows no longer deserved the name. When Man takes something from Nature he must make sure that Nature is able to replace what he takes, and that he is not robbing one person to supply another.

Before it was realised that diseases are caused by germs, drinking water was taken from the river Thames, into which the sewers of London also emptied. The Thames is probably even more filthy today but Londoners still drink its water, although now of course, the water is purified. Many of the germs die in the stillness of the reservoirs into which the river water is drawn; then further impurities are removed as it flows through beds of sand. Finally to make it perfectly safe a minute dose of the gas CHLORINE is passed into the water and it becomes germ-free and wholesome, yet remains tasteless—unlike the eye-stinging water in some public swimming baths which is treated heavily with chlorine to prevent bathers from infecting each other.

We are fortunate in being provided with safe clean water, but had it been possible to take the water straight from the air, before it fell as rain, we would have water more pure and fresh than the most careful water company could provide. Where the rain fall is insufficient to provide the water which is needed attempts are sometimes made to take it straight from the air. On top of the rock of Gibraltar metal mosquito nets were set up like hurdles. As clouds passed over the rock, water was CONDENSED in the mesh and flowed into tanks—sometimes at the rate of one gallon per hour. If enough of these 'strainers' were erected they would be a great help to the people of Gibraltar during the dry season.

Dew is water which has come from the air in the cool of the night. In hollows near the tops of the chalk downs of England may sometimes be seen small ponds. They are at too great a height to be fed by springs and, as water remains in them even during the driest summers, it is not the rain that fills them. Sheep drink their fill daily from the ponds, no-one can see water running into them and yet they do not dry up. It can only be supposed that, during the night, dew CONDENSES on the pond's fringe of reeds and grasses and on the cool surface of the water itself, so that they have come to be known as 'dew ponds' or 'mist ponds'.

Scientists who are studying the problems of growing crops in places where there is little rain are beginning to wonder if the people of ancient times knew more about the value of dew than we do. We think of the Bible as a book for reading in church or scripture lesson, but it can be used as a book of science or history too. The ancient Jewish writers speak of dew more often than they do of rain and always think of it as a blessing. Perhaps the 'dew upon the desert's face' was more benefit to the ancient Israelite farmers than the rain which so seldom came. There remain in the desert of southern Israel, many small mounds of stones which puzzle the modern scientist. They could be merely piles of unwanted stones, or they could have been designed to send rainwater into channels as a roof does; but some think that they were placed deliberately by ancient farmers who knew that on the cold surface of the stones the heavy dew of the desert night would *condense*, moisten the ground beneath and allow a vine, a fig or an olive tree to grow. Certainly the Arabs call them by a name which means 'hillocks for grape-vines'. The people of modern Israel will try to find out if they are right so that they can make the best possible use of their dry land of Negev.

This photograph was taken in the area of Brazil where the rainfall is so unreliable that at different seasons cattle may die from lack of water or be carried away by floods. (Photo: Paul Popper Ltd.)

So far we have thought only of water on its way to our tap or to the well, but for those of us who live in modern houses water has been given another job to do after it has been through our sinks and basins. It goes down into drains, carrying dirt with it, and is joined by the waste from our lavatories. Now it is far better for our health that sewage should be carried away and made harmless or pumped out to sea than that it should be emptied into the streets or gardens as it used to be less than two hundred years ago. The sad thing is, however, that the body's waste products contain chemicals which are needed by the soil. Cattle eat grass which the soil provides, but they in their turn provide manure which is spread on the soil by the wise farmer. Humans eat food produced by the soil but give nothing back! One problem which farmers and health experts need to solve is how to make use of sewage without endangering people's health.

Another problem is set when too much rain falls and when rivers overflow their banks. Then engineers have to find ways of draining land and of controlling the floods. But although one can sometimes have too much even of a good thing like water, we will always have to continue our search for fresh reliable supplies. Water makes up 7/10 of your body's weight, so it is easy to see why you would not be able to live for more than a few days unless some of this very common liquid was available.

FACTORY BENEATH OUR FEET

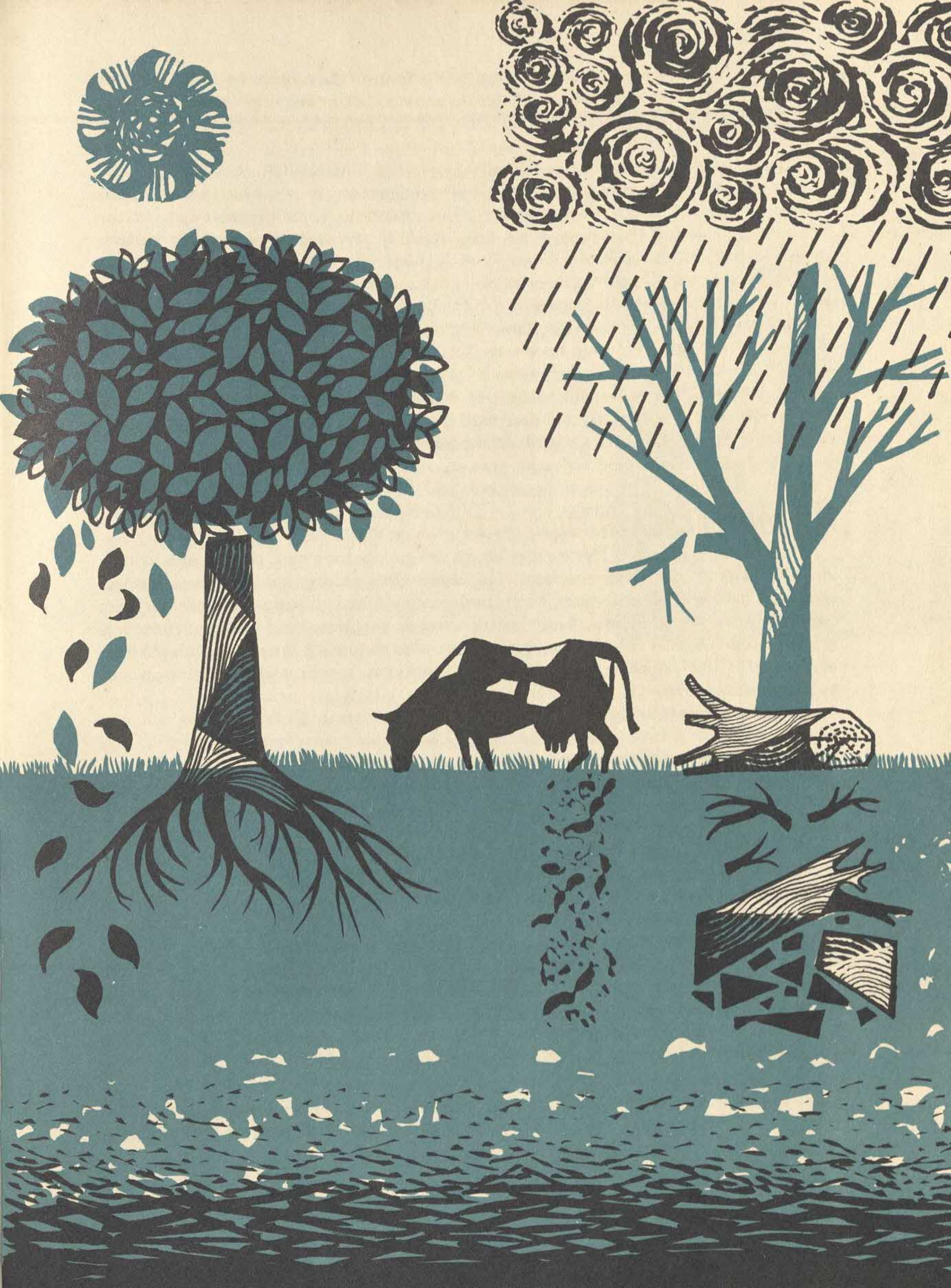
The dying farmer told his idle sons that a treasure was hidden in his orchard. Though they were not fond of work they were greedy for gold and they started to dig beneath the trees. Of course they found no chest of coins or precious stones, but the fruit trees profited so much from the turning over and breaking of the land that they brought forth a valuable crop of golden plums and ruby-red cherries . . . That is the old story and although it is doubtful whether digging alone would greatly improve the fruit crop, it does show that our fortunes may be hidden in the soil about which we often speak so unkindly.

We talked about 'soiling our hands' or 'soiled clothes' when we really mean they are dirty with oil or ink or coal. Sometimes we even refer to the soil as 'dirt' as though it were something which should be removed or covered over instead of being the source of most of our food and clothing. The sad thing is that much of our soil is being either removed by rain and by bulldozers, or covered over by houses and roads which spread from growing towns over the farm lands of the countryside.

To most of us the soil looks dead, dull and dirty. It sticks to our shoes and gets under our finger nails. It cannot move of its own accord and it has to be turned over and broken with spade or plough if we are to grow anything in it. Yet there is more life below the surface of your garden than there is above. A few of the soil's inhabitants, the worms and grubs, we see when we turn over a spadeful; but the rest are MICROSCOPIC. In a salt-spoonful of soil there are as many microbes or BACTERIA as there are people on Earth.

These tiny creatures are the workers preparing food for plants in the factory of the soil. We humans are able to eat the flesh of an animal and the leaves of a plant—though

In Nature everything which lives and grows eventually returns to the soil from which it originally came.



we may prefer the food to be cooked for us in the form of roast beef and cabbage. Most plants receive food in liquid form through their roots, but it would be no use trying to grow a rose bush or a tomato by allowing it to stand in a jar of rich meat gravy or vegetable soup!

There are in some swamps where the soil is poor a few CARNIVOROUS plants such as the bladderwort or the pitcher plant, which kill and digest any insects which are unfortunate enough to crawl into their traps. Other plants, however, cannot eat meat or make use of any of the food we like unless it has been specially prepared for them. The bacteria which prepare plant food do not simply cook it, they change it completely. We call this change *decay* or *rotting* and we may think of it as something unpleasant which should not happen when everything is clean and tidy. But when something in your garden rots it is changing its form and breaking down into the simple chemical substances which the soil needs if plants are to grow once more in the garden beds. The bacteria of the soil use the OXYGEN of the air in their work of making the NITRATES which all plants need as food. Many of the other substances, the NITROGEN and AMMONIA which the bacteria use are taken from old and dead materials such as are found in COMPOST beds and manure heaps. The bacteria work on the leaves, manure and other dead ORGANIC matter and turn it into food for more growing and living things. Other bacteria which live in the roots of such plants as beans, peas and clover, are able to capture some of the *nitrogen* from the air and turn it into NITRATES which feed these plants and enable them to produce the important type of food known as PROTEIN.

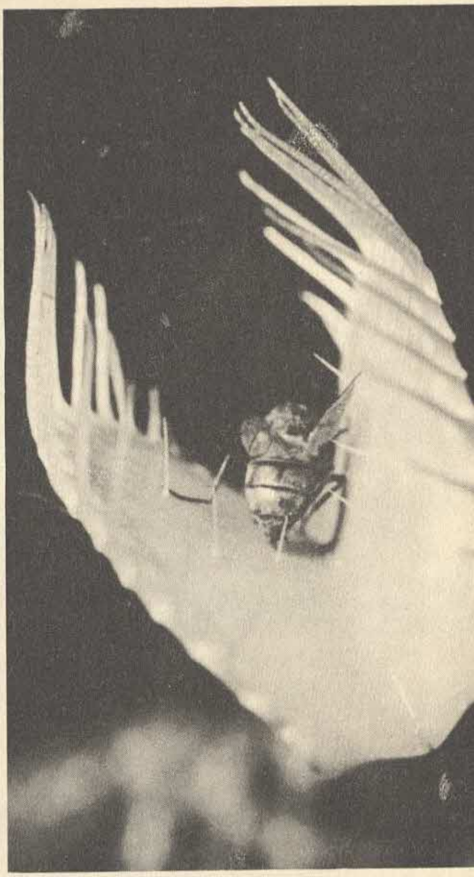
All animals need PROTEIN; we may obtain our supply from beef, cheese, eggs or milk which come from animals on the farm. The farmer does not feed his stock on roast beef or bacon and eggs, so that cattle, sheep and poultry have to obtain their protein from vegetable foods such as clover, beans, grass or corn. All plants need *nitrates* as much as animals need *protein*. Clover, beans and peas are able to provide their own with the help of the BACTERIA in their roots; but grasses, cabbages, turnips and corn need the soil to provide it for them.

The farmer may help the soil either by spreading manure or COMPOST, which thus gives back to the soil some of the substances taken from it by plants and animals. Not every farmer has sufficient manure or compost for his fields so he gives them a dressing of NITRATES which come to him in large paper bags. The NITRATES which he buys may have been manufactured or they may have been dug out of the ground in such places as the Atacama Desert of Chile. The farmer may even call upon Nature to provide the NITRATES for him by growing a crop of one of the LEGUMES solely for the purpose of ploughing it into the soil again; or he may simply ROTATE his crops so that every four years a field of clover is grown and sufficient NITROGEN is thereby captured and fixed in the soil for the next few years.

In the wild state plants, animals, soil and bacteria help each other. Life travels in circles from the soil to plant, from dead plant to vegetation rotting where it falls and back into the soil again with the help of bacteria. A larger 'circle of life' includes animals which eat the plants, nourish the soil with their droppings and finally lie down to die, leaving their bodies where they may decompose and their substances be carried into the soil again by other smaller animals and the ever present bacteria.

But when Man comes on the scene the circle is broken. He cuts down and perhaps burns the trees, he ploughs in the grasses, he chases away the wild animals and plants corn or cocoa. For several years he has splendid crops but there comes a time when, as

In swampy land, where the soil is unable to supply nitrogen, plants gain nourishment from insects which are trapped in their leaves. (*Photo: Paul Popper Ltd.*)



the harvests grow smaller, he finds it not worth planting there any more and he abandons his fields or forest clearing and moves on to find fresh soil. The land he has used does not always, however, return to its original condition. The soil now short of nourishment, does not again support tall forests or thick grassland; the rain washes it away for now there are fewer roots to hold it together. The sun of summer dries it and the winds whip up the loosened soil and bear it away in clouds of dust. The early settlers in America wasted many acres with their ploughs, and still in parts of Africa and South America natives cultivate the forest with axe and hoe because it is easier to destroy trees than to give the soil what it needs.

The lesson is taught that you cannot have something for nothing. You cannot continue to take from the soil unless you add to it. If someone inherits a fortune and begins to spend without ever earning anything there will come a day when nothing is left. We have inherited several fortunes—the air, the sea, the soil. The air and the sea are always on the move, always changing and always being renewed; so no matter how much *oxygen* or *nitrogen* we take out of the ATMOSPHERE there will always be plenty left for next year. No matter how much salt we take out of the sea we cannot use it all. We could, if we were not careful, catch too many herrings or whales and cause a shortage for the future, but the water of the sea will last for ever. With the soil it is different. It is not simply powdered rock, of which there is plenty, for it contains salts, bacteria and ORGANIC remains which we call HUMUS.

Humus helps to make clay soil lighter and holds moisture in sandy soil, it provides a home for *bacteria* and makes soil darker in colour so that it absorbs better the heat which it receives from the sun.

Man has learned to take from the soil more quickly than he has learned to pay back. Unlike the animals he will not spread his body's wastes upon the fields, for to do so would be unpleasant and unhealthy; nor will he bury the dead in the fields to provide food for soil bacteria. Instead he washes sewage into rivers and the sea, puts vegetable scraps into the dustbin instead of onto a compost heap (but what else can he do if he lives in a town or has no interest in gardening?), and out of respect for those whom he loved, and to prevent the spread of disease, he either cremates or buries his dead relations in a cemetery.

We are not so wasteful of the fertile lands of the world as the pioneers were about 100 years ago when the new cheap lands of America were there for all who could wield an axe or drive a plough. Now that all the easy farm lands of the world have been brought into use we are looking for ways of making crops grow in places which once would have been called useless. Farmers are now seeking ways of saving land rather than of wasting it; and, because the population of the world is growing so rapidly so that every year more food is needed, agricultural scientists become excited when they discover a way of growing giant-sized cabbages or find a type of wheat which will give an extra four or five bags per acre. Such discoveries are, of course, marvellous but they do make a problem for the soil expert. 'For', he explains, 'you must not take out more than you put in. These super plants will need more mineral salts from the soil. We must make sure that the bacteria have enough to feed on and we will have to spread the soil with more farm-yard manure'.

'But we cannot do that', says the farmer, 'for already we sweep up every scrap our animals leave, and besides some of us have fewer animals now that tractors have taken over from the horses'.

'Then', replies the soil expert, 'you will have to turn every scrap of ORGANIC matter you can find into COMPOST and you will have to spread chemical fertilizers by the ton. You will have to pay high prices to bring nitrates from Chile or your chemists will have to make them from the nitrogen of the air; you must dig more lime or chalk and use more trucks to carry it. You must be prepared to use millions of tons of coal to make your *superphosphates* and *sulphates*; and you must add all these things and many more to the land—sometimes one, sometimes more of another, for the soil must remain balanced just as your diet is balanced with meat and vegetables, bread and fruit'.

Please do not think of soil as a lot of brown dirt for it plays a bigger part in our lives than is generally realised. If people are to be healthy they need good food and, apart from fish, all food comes from plants which grow in the soil of fields and gardens.

SOIL—SERVANT AND MASTER

It is a pity that we cannot grow cabbages and beans at the bottom of the sea for that is where some of the world's best soil is! Of course it is no use to us there, but that is where it has been washed or blown from the land by the winds and rain of thousands of years. Every particle of soil at present on Earth's surface will eventually end up in the sea, but it is most important that we should not allow it to disappear too quickly—at least not before new soil has been formed, with the help of bacteria and rotting plants, from the rock weathering and crumbling beneath us.

Soil takes a long while to form but it disappears very quickly if it is not protected from wind and rain. Already too many rivers are coloured red or yellow or chocolate brown with the soil which they are carrying to the sea. Rain washes away soil but it is not the places which have a high rainfall which suffer most; Pondoland in South Africa suffers from drought for most of the year, but during the summer, heavy storms of rain wash the dried and broken soil into short, rushing rivers of muddy water and down into the Indian Ocean.

The Mississippi River, which drains 28 of the United States of America, also robs them of their soil and drops 400 million tons of it every year into the Gulf of Mexico. Some of the water of the Mississippi comes from the Tennessee River, where the T.V.A. has done a great deal to stop the soil of the valley from being washed away, by building flood control dams and by planting trees on the bare, scarred hillsides. Many Americans believe that a single Authority should control all the waters of the Mississippi and that what has been done for the Tennessee Valley should now be done on a much larger scale.

Man can control floods with huge concrete dams but he can also plant trees and get

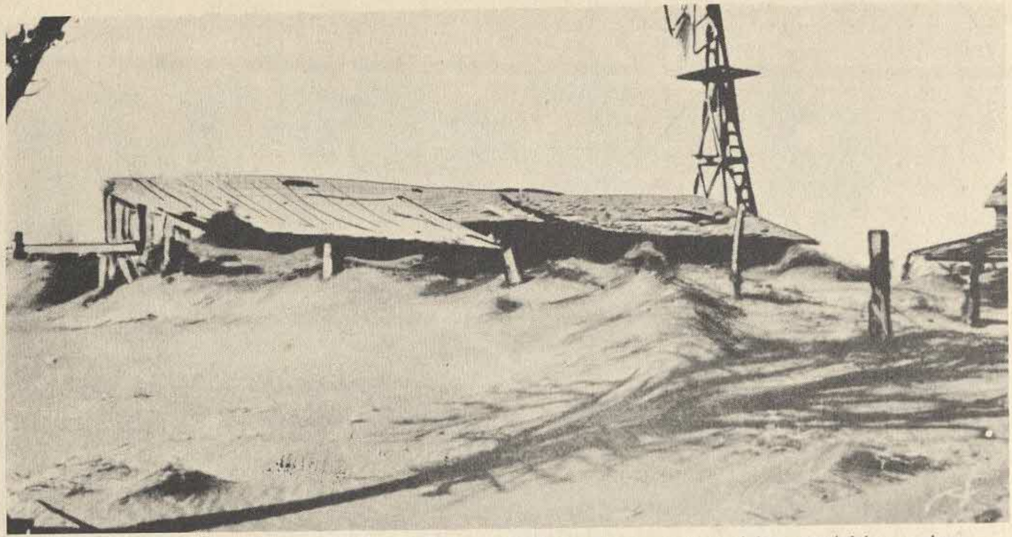
Running water can remove soil as well as wind. This river is dark with soil particles which are being washed away. (Photo: J. Allan Cash)

Nature to help him in a much less spectacular way. Trees on hillsides break the force of heavy rain with their leaves, and their roots hold together the soil particles. Through the leaves, roots and HUMUS slowly percolates the water which otherwise might rush madly down, carving gullies, and sliding sheets of soil with it. Hedges, such as grow in English fields, when planted along a hillside act as buffers onto which sliding soil may run and pile up. Often the ground above a hillside hedge will be much higher than the ground just below. The hedge has checked the SOIL EROSION. But in Britain, where the rainfall is gentle and the soil is able to absorb it, the hillside fields do not suffer much from EROSION.

Where rain storms are heavy and sudden as in some parts of America and South Africa it is unwise to plough a hillside field from top to bottom, for the furrows act as channels down which water flows to become miniature torrents of mud and uprooted plants. So farmers practise what is known as CONTOUR ploughing and make their furrows run level along and around the hillsides. Each ridge raised by the plough then acts as a dam and catches the soil which slides from the ridge above. Even if a hillside is steep the sliding soil may be stopped if terraces are made like great steps upon which crops are grown. In the Far East even the rice fields are on terraces, and the ponds of water, in which young rice is planted, are held in check by dams along the terrace edge.

A farmer may be anxious to plant a hillside with corn yet he knows that the roots and stems of the crop will not bind the soil as would a carpet of clover. If he is wise he plants his field in horizontal strips—clover, corn, clover, corn. Any soil which slides from the corn strip will be held by the tight mat of clover, and another year the clover and corn can change places. The clover may be cut and fed to animals or it may be ploughed in, so that the following year's corn crop can benefit from the HUMUS which the rotting clover becomes, as well as from the NITROGEN which its roots have given to the soil.

The wash of heavy rain on bare hillsides is not the only cause of SOIL EROSION. The



This was once a prosperous Texan farm which has been covered by wind-blown dust.
(Photo: Paul Popper Ltd.)

wind also can skin the soil off the fields and drop it where it is not wanted. Over the high plains of Oklahoma and Kansas the wind may blow hard for weeks at a time, but the settlers inherited a rich soil, undisturbed by the weather because it had been protected by a covering of grass for thousands of years. In North Dakota, another prairie state, a story is told of an old Red Indian who watched the first ploughs as they came and turned over his grass land. He may not have known anything about *erosion* but, when he saw brown appearing instead of green behind the plough, he pointed at it and grunted 'Him wrong side up!'

Some of the prairie should never have been disturbed but it made good wheat land and, during the years when there was plenty of rain, crops were good. The 1920s were fruitful years and fortunes could easily be made by those who were willing to take from the soil without paying. The 'suitcase farmers' came—men who bought land cheaply but did not live on it or care for it; who were willing to grow large crops and afterwards sell the land at a loss or abandon it, satisfied with the loot of the large harvests.

The 1930s came—the 'Dirty Thirties' as they have been called—years of drought and high winds. The neglected fields of the departed 'suitcase farmers', unguarded by hedges or trees, were the first to lose their covering to the unchecked wind. The dry soil grains hopped and nudged each other and jumped in clouds from field to field. Farmers, anxious for bigger harvests to provide them with the money which was to pay the installments on their new machinery, had ploughed up land which should never have been disturbed. The soil had its revenge for having been turned 'wrong side up' and took flight before the wind. Young shoots were flattened and torn up by the roots. The more soil the wind gathered the more damage it was able to do. Moving soil stirred up still soil and set that moving too. Uprooted plants were driven along, first flattening and then uprooting those next to them.

Even the farmers who had cared for their land suffered, for nothing separated them from their neighbours except perhaps a strip of wire or an unfenced road. Their young shoots were uprooted too and their furrows filled with dust—dust which covered roads, piled up against houses and barns, filtered through closed windows and choked the lungs of those who breathed it. The soil had been badly treated as a servant and now had turned round to become a cruel master.

In Texas houses were buried beneath good black soil which the wind swept off the farms of the West. The same wind is thought to have removed, in one day during the drought of 1935, some 50 million tons of soil from the fields of Oklahoma.

While this was going on many farmers lost heart, gave up their farms and took what work they could find in more fortunate districts. Others who were more determined and had no wish to lose all they had worked for, continued the struggle and did what they could to prevent their fields from disappearing. With special ploughs called *listers* they cut across their fields deep furrows with high ridges which acted as walls to hold back the drifting soil.

Meanwhile, as the clouds of dust darkened the sky even over New York and Washington far to the east, the U.S. government joined the battle and started the Soil Conservation Service. Soil scientists and technicians thought out new ways of farming. The usual method of ploughing causes stubble and weeds to be turned under so that a bare clean surface is given to the field. A new type of plough was invented which cut the roots but which left stubble and weeds standing to provide a protective cover for the soil. Another plough threw little dams across the furrows so that rain water would not rush away but would lie and be given a chance to soak into the soil. Farmers were taught to plant tall and short crops, alternately in ten-foot strips which ran across the direction of the wind and helped to break its force. New deep wells were dug and water was found to give to the land in the dry years.

The 1940s were good years again on the high plains, but this time the farmers did not waste and plunder the land. Instead they looked after it, and when the bad times came again in the 1950s they were able to continue farming and making a profit. They had learned how to make the soil a good servant. Now dust storms still come but they are much less dangerous than they were from 1932 to 1939, and the land which in the '30s was given the name 'Dust Bowl' produced 8 million bushels of wheat in 1958.

There are, however, many other parts of the world where Man and the soil are still struggling to find out which is master. In China and Australia SOIL EROSION still causes a great deal of worry, and in North Africa the fight goes on to prevent the march of the Sahara Desert. By planting trees which act as wind breaks and bind the soil with their roots, by careful watering and cultivation, and by farming for the future rather than thinking only of this year's harvest, Man may be able to save or improve the soil of millions of acres throughout the word. It will be a long and expensive task, but the value of the soil cannot be reckoned in money for it is the source of food for the thousands of millions who have not yet been born.

PLANTS AND PEOPLE

An old farmer was once asked how he managed to tell the difference between young vegetable plants and weeds. He is supposed to have replied, 'Pull them all up, and if they grow again they are weeds!' Many of us who have tried to grow things in our gardens must have felt as the old farmer did. There seem to be two types of plants, the useful

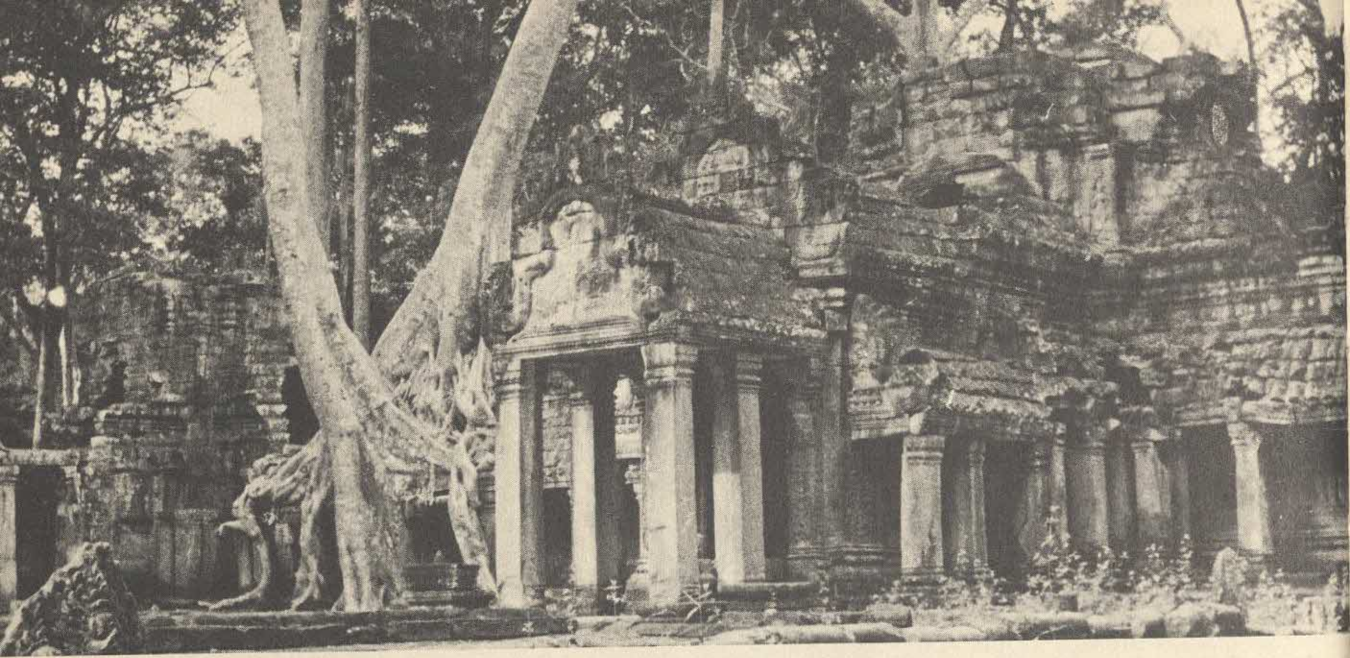
and the annoying; and those which we do not want often appear to grow more easily than the valuable lettuces and flowers. Some story writers have imagined giant creepers or horrible cacti which were making themselves masters of the world and which acted as though they had minds filled with hatred towards Man! Fortunately such plants do not exist outside the pages of Science Fiction books though many people, when they have seen weeds springing up through the cracks in a concrete path, or looked on the remains of one of the lost cities of the Mayas swallowed by the tropical forest of Central America, must have felt that Man is a rather feeble creature surrounded by unconquerable plant enemies!

Fortunately for us this is not true for Man has had such an effect upon the plants of the world that it is often very difficult to know what was the NATURAL VEGETATION of any place. The forests of England, where once Robin Hood wandered far and wide, have nearly all disappeared and much of the woodland of today consists of trees which would not have been there in the Middle Ages. In other countries too the work of Man's hand may be seen; the rubber tree, HEVEA, which once grew wild only in the Amazon forests now grows in plantations in Malaya. When we talk of cocoa we think of West Africa—not of America where it originally came from. We sing a song which tells us that there is 'lots and lots of coffee in Brazil', but we do not mention that it came in the first place from Arabia. Wheat grows so well in so many different parts of the world that it is difficult to believe that it started as a type of wild grass somewhere at the eastern end of the Mediterranean.

Man has been so successful in making plants grow where he wants them that we sometimes give the label 'weeds' to those which grow without permission where we would prefer to see something else growing. To do this is unwise, however, for we often find that plants which once were thought a nuisance are now extremely useful, and we are always looking for ways in which they can be made to serve us better. The early settlers in America wanted to grow wheat where stood forests of fir and pine, maple and spruce. To them the trees were like giant weeds and they chopped and burned without regret so that for years those who lived in Michigan were used to the smell of burning wood coming to them on the wind. Now we realise how stupid this destruction was for we have learned that trees help to keep moisture in the soil and are themselves a valuable crop. Not only do we need wood for furniture and buildings but also for pulping to make paper. One American newspaper alone needs a forest the size of a small English county to keep it supplied with newsprint. The United States has been using its timber much more quickly than its forests can grow, and now Americans realise that they must take care to provide for the future.

Gone are the days when trees were felled as they were needed and when Nature was left to fill the gaps. For Nature does not always replace what has been taken, but covers the ground with a growth of scrub and small bushes. It falls to the forester to look after his forest for now there is more to his work than just felling. He raises saplings from seeds, plants the trees he needs and makes sure that they have enough room to grow by cutting out some of the trees when they become too thick on the ground. He leaves broad, clear strips through the forest so that, if fire breaks out, it will not spread too far. Fire does millions of pounds worth of damage every year and, during a dry summer, a careless smoker could unknowingly start a blaze which could destroy several hundred square

Skillfully the draveurs *guide the logs down river from the forests to the saw mills.*



Great walls were pushed aside and ancient temples were covered when the forest took possession of the once busy city of Angkor in Cambodia. (Photo: Paul Popper Ltd.)

miles of valuable forests. The forests of America are no longer deliberately destroyed but are guarded by a band of fire-fighters, who may be called by radio from a remote watch tower and dropped by parachute in some part of the forest too far away to be reached quickly by road.

Man has become an impatient creature. He needs trees quickly so, instead of planting hardwoods such as oak, ash or beech which will not be ready for cutting for over a hundred years, he more often plants soft woods—fir, pine or larch which will be ready for harvesting in half the time. The days when oak trees were valued because they provided timber for ships have gone; now the need is for paper and for easily worked soft wood which can be used by house builders. So, to meet the new demand, the woodlands of Britain are gradually being changed. Now oak, ash and elm are becoming less common and neat patches of young evergreens take their place.

Because trees are much more scarce than when they were regarded as weeds, less familiar varieties are now being tried. Once the West African were interested in little besides mahogany. Now that mahogany is difficult to obtain they have learned how valuable is OBECHE—a fine wood which before 1940 was regarded as useless. Wood is far too precious to waste and, because a saw-mill is only able to make about a half of a tree trunk into planks, the timber merchant is anxious to turn scraps and waste into useful material such as plywood and fibre board.

We now cultivate trees but cannot imagine that anyone would cultivate a crop of nettles, yet these plants have been useful. When boiled they are said to be like spinach though few of us would like to try them. Some country people, who remember the old recipes for making drinks out of such unpromising plants as dandelion, burdock, elder flowers and cowslips, have used nettles for making beer; and our early ancestors used fibres of nettles to make a type of cloth.

Grass is weeded out of our tidy garden plots, but grass in the field is one of Earth's most valuable crops for it is the chief food of animals which provide us with meat. Better crops of grass mean that more animals may be kept in each field, so it is not surprising that farmers are very careful to choose and sow the types of grasses which are most suitable for their animals and which grow best on their land. The sheep of New Zealand grow fat on grasses which came as seeds from English fields, and it may be that the 'blue grass' for which the American state of Kentucky is so famous, was brought to the New World by some of the first settlers.

One advantage grass has over other crops is that it does not have to be sown every year. Now, by crossing wheat with a type of grass, a new wheat plant has been developed which is PERENNIAL. If this crop was sown in loose soil it would help to bind it and be a useful weapon against SOIL EROSION instead of helping to cause it.

Another type of grass—marram—grows in loose sand. If it is planted on dunes round the coast its roots weave together to form a mat which prevents the wind from spreading sand over the inland fields, and makes of the dune a wall which stands more firmly against the sea than would a wall of concrete.

Some of the plants growing amongst the meadow grasses were once thought to be useless, but now farmers realise that small quantities of dandelion, daisies and yarrow are good for their animals, whereas the buttercup which looks so good and which sounds as if it would encourage cows to yield rich milk, is now called a weed.

In the search for a new form of food for his cattle Man changed a harmless stranger into an unwelcome guest and gave himself the problem of dealing with a new type of weed. In 1839 the prickly-pear cactus was taken from South America to Australia. It was hoped that, as well as providing food for cattle in years when drought caused the grass to die, it would be useful for hedging and an interesting curiosity. The prickly-pear liked Australia for it found itself safe from the attacks of its South American enemies. Soon it was not content to remain where it had been planted but escaped and spread over 60 million acres of Queensland and New South Wales. (Perhaps it was a cactus of this kind which gave the Science Fiction writers the idea of evil-minded plants seeking to conquer the world—certainly the prickly-pear seemed to be well on the way to conquering Australia!) The grass lands were becoming choked with the cactus, so that there was less food for cattle instead of more, and a way had to be found of checking its growth.

Again the biologists went to South America to look for the plant's enemies. They came back with a moth, the grubs of which bore into the cactus and eat it. 3,000,000,000 of these moths were turned against the cactus and within a few years the danger had passed. Now nearly all the land is back to its original condition and the borer moth continues with its job of weeding.

The story of rubber is much happier than the sad tale of the prickly-pear for 70,000 rubber seeds, smuggled out of Brazil and planted in the steaming glasshouses of Kew Gardens, became the parents of trees which were taken to Malaya. From them and their offspring came the rubber which made the fortunes of Malayan plantation owners in the years to come.

In Kew's glasshouses, which can make a tropical climate only an hour's ride from the centre of London, have been reared plants which were taken successfully from one part of the world to another. Chinchona trees, from which we obtain quinine, were taken from Peru to Ceylon, and tea from China was taken to South Africa and to India by way of Kew Gardens.

Trees are a valuable crop and must be guarded from fire. The open lanes would prevent any fire from spreading too far, and from the look-out towers observers keep a careful watch.

Kew has been well known to botanists for many years but recently a centre for studying plants has been opened in the South of France. At the University city of Montpellier is an electronically controlled laboratory which can imitate any climate in the world. Here biologists can see what happens to plants when the temperature changes or when they are supplied with varying amounts of water. By carefully noticing what happens when the water supply is reduced or when the heat is increased scientists hope to find out exactly why certain plants grow where they do and whether they could be expected to flourish if taken to another part of the world.

Kew and Montpellier are places for finding out and it is hoped that they will provide scientists with an accurate knowledge and understanding of plants and their needs, so that when Man decides to interfere with the green world which surrounds him there is a good chance that he will do so to his advantage.

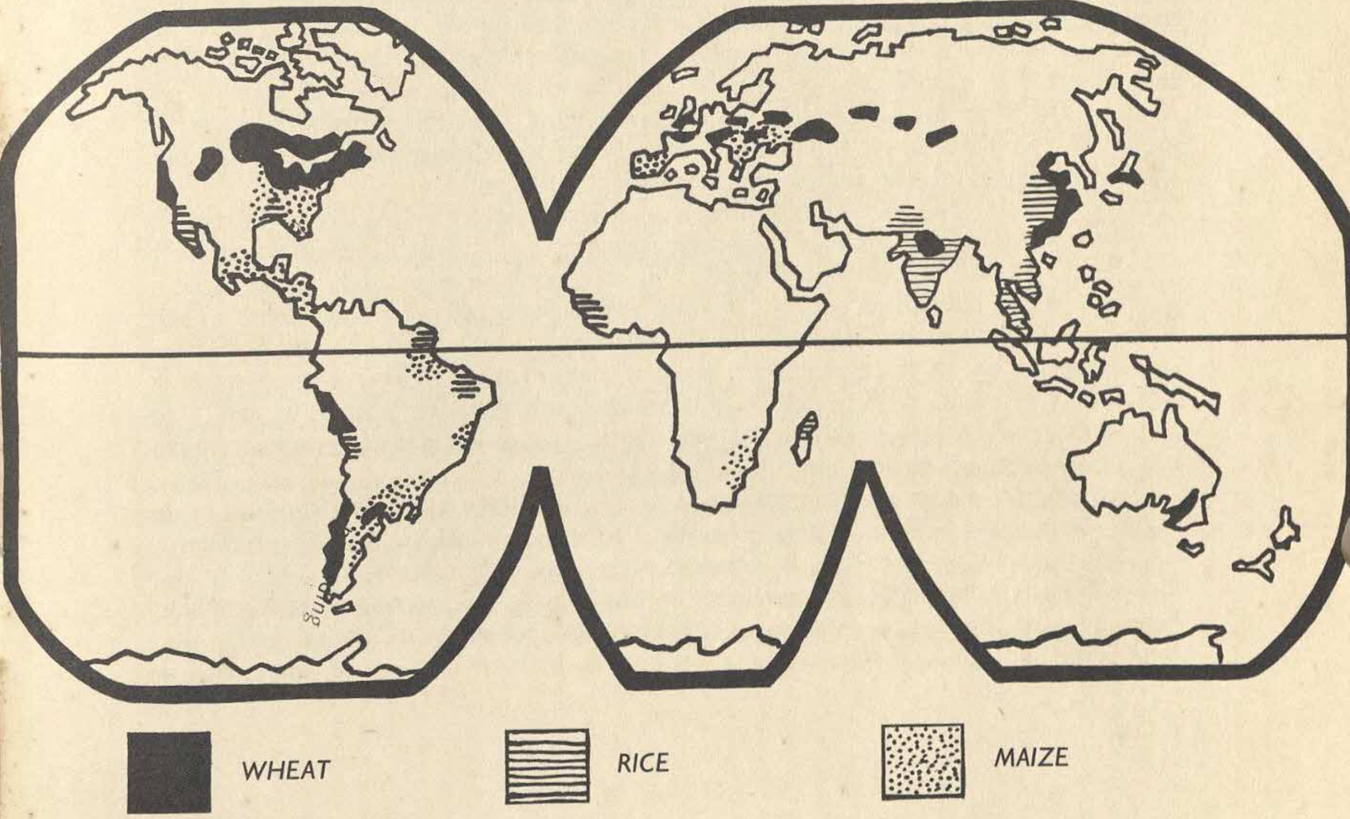
Many of us like to play a guessing game in which we describe the objects we are thinking of as: *animal*, *vegetable* or *mineral*. Sometimes it is rather difficult to decide what an object was originally; and we may find, for instance, that even one piece of furniture has something of all three in it; a chair may have a wooden framework (*vegetable*), metal springs (*mineral*) and be covered in leather, which of course began as part of an *animal*. It would be rather silly to try to decide which of the three groups is the most important, but it would not take us long to find out that we would not be able to live at all without making use of the vegetable kingdom. From plants we obtain the cotton and linen of our clothes, the paper of this book, building materials, dyes and thousands of other useful things. Some of these we could do without or could use more economically; for stone and iron, or plastics and nylon, which begin as minerals, can satisfy many of our needs. But we cannot do without plants as food, for they can do what we find impossible—they grow big and fat upon a diet of air, rain and the minerals of the Earth. All our food comes from plants or from animals which feed upon them. If we eat chicken or beef we are really eating corn or grass which an animal has changed into meat for us.

Very few of us would care to change our eating habits but when we are eating meat we are using plant food in the most extravagant way. If, instead of eating corn ourselves, we feed it to animals, we would find that for every pound of meat they could give us we would have given them as much wheat as would have made about a dozen small loaves of bread. It is not surprising then that more people can live off a patch of land if they eat plants than if they allow animals to turn the plants into tasty meat for them.

As more people come into the world so more food is required and plants will have a bigger job to do. There cannot be may types of plant which have not been tried as food—sometimes with happy, sometimes with fatal results—but it is possible that chemists will find ways of making new types of food from plants which we would think most unappetising. We all need PROTEINS, and in the future some of this necessary part of our food may be made from grass or even from a type of duckweed!

Food of this kind, turned out by factory machines, does not sound very exciting; but the idea of bigger and better vegetables or richer, more juicy grapes and fatter oranges is one which would please both greengrocer and customer. Chemists and agricultural scientists are always looking out for ways of treating crops to produce more food. One

Map showing parts of the world where important cereal crops are grown.



Planting rice in the paddy fields of Java. (Photo: Aerofilms Ltd.)

recent discovery is *gibberellic acid*, a white powder which some Japanese scientists produced from a pale pink mould forming on diseased rice plants. Very small amounts of the powder have been dissolved in water and used as a crop spray. Some growers who used it found that they got larger crops of grass or grapes or oranges. In America it was tried on some young cabbage plants which then grew to be ten feet tall—though we are not told whether the cabbages were worth eating! When more is known about the strange substance farmers may make greater use of it to encourage the growth of their crops.

Nothing can make a plant grow, however, if the soil or the climate is unsuitable. *Gibberellin* will not help bananas to grow in the Arctic nor rice in the desert. Farmers choose to grow the plants which they know will thrive, and it is possible to draw lines across a map of the world to mark the limits of such crops as maize, wheat, grapes or oranges. The wheat growing areas are the widest of all and wheat is the main food of hundreds of millions of people. If we had to choose one type of food on which to live, and were forbidden any variety in our diet we would be very miserable and our health would suffer; but we would be making the best of a bad job if we chose rough wholemeal bread as our food, for the wheat from which it is made contains most of the things necessary to us. To grow wheat in places where it has never grown before would therefore be one of the best ways of providing food for the growing population of the world.

Sixty years ago the two Canadian provinces of Saskatchewan and Alberta were thought to be too dry for grain growing. Now the provinces are famous for their wheat fields but the climate has not changed. Instead plant breeders have discovered hardier varieties of wheat which take about 90 days to ripen and become ready for the harvest. There is also good land near the Mackenzie, a Canadian river which flows into the Arctic Sea, but the region has on the average only about 66 days in the year when there is no frost. If a variety of wheat could be EVOLVED which would resist the cold in its early days and which would ripen quickly in the long sunlit days of the northern summer, wheat could even be grown beyond the ARCTIC CIRCLE.

There may of course never be any great demand for large quantities of wheat in the Arctic for it would be difficult stuff to export from places which are linked with the outside world mainly by aeroplane. It is expensive to carry large cargoes of food by air, but food is needed in the Arctic, for people are moving in to work in weather stations, military bases, uranium mines and, perhaps in the future, in coal mines and on oil wells. Then fresh vegetables, milk, butter, cheese and eggs will be needed. So some crops, perhaps cabbages, potatoes, oats, barley or grass will need to be grown; and varieties which can resist the frost and which will ripen quickly will have to be found.

Plants have been EVOLVING and slowly producing new varieties for millions of years, but when plant breeders take a hand in the process they look out for a plant's chance MUTATION and, if the new plant seems to be better than its parent, they keep its seed, watch how it develops and look out for fresh changes in its offspring. It is because of this process of SELECTION that our garden fruits are so much bigger and better than their wild cousins. The different varieties of wheat which farmers grow, or the different types of apples which we pick from our orchard trees are all the results of MUTATIONS which seem to have happened by chance. Scientists are beginning to find out what causes these changes and they know that if a living creature, either animal or plant, is exposed to strong rays from a RADIO-ACTIVE substance it produces a thousand times as many mutations as it would under normal conditions. Human beings do not want to expose themselves to radiation for it could hurt not only their own bodies but also the bodies of any children who might be born to them. But the plant breeder is willing to destroy a thousand plants in order to find one which will be useful to him.

He knows that most of the offspring of a plant which has been treated by radiation will be useless weaklings or dwarfs or unable to produce seeds; but one or two may show signs of having some quality which is needed. These are kept, planted and used for future experiments. In Sweden barley has been treated by radiation and new types have been produced—one with a stronger stalk which withstands the beating of heavy rain, and another type which takes three weeks less to grow than its parent. The same thing may in time be done for wheat and then the dream of Arctic cornfields could come true.

New ways of farming, new plant foods, new types of plants and newly developed farmlands will all help to fill the world's pantry, but unless Man fully understands what he is doing he may be unlucky and empty his purse instead. In the years after the war fats were very scarce and, in the hope of providing the British people with margarine and with oil for cooking, £23,000,000 was spent by their Government on an attempt to grow ground nuts (or peanuts) and sun-flowers in Tanganyika. It seemed at first to be a good idea; there were already, in a few places, small plantations of ground nuts and there appeared to be large areas of bush which only needed clearing to give plenty of land for crops. Unfortunately the land was not surveyed thoroughly, nor was any serious attempt made to examine and understand the soil. Bulldozers came and attacked the land. The roots of trees and bushes had anchored the soil and once they were removed EROSION began. The peanuts were planted and the tropical rain and sun turned the soil into a cake as hard as cement. The deep rooted bushes had been able to find water but shallow rooted peanuts were not so fortunate, and they withered and died.

Large areas of bush had disappeared, but the bees which lived in the bush disappeared too, and bees are needed by sun-flowers to carry pollen from one to another if they are to produce seeds. Bees had to be flown in from England to replace those which had vanished in Africa. But even this unusual remedy did not save the crop and, in spite of great efforts and much money, the plan failed. It was an expensive lesson but perhaps we will profit from it and learn that Nature must not be treated as an enemy and attacked by a great army of bulldozers if she is to produce plants to feed us. Plants will grow for us and will provide us with more food if we study their needs first. The world needs more in its pantry but we must ask politely for it to be filled—not try to snatch what we want greedily and thoughtlessly.

ANIMALS AND MAN

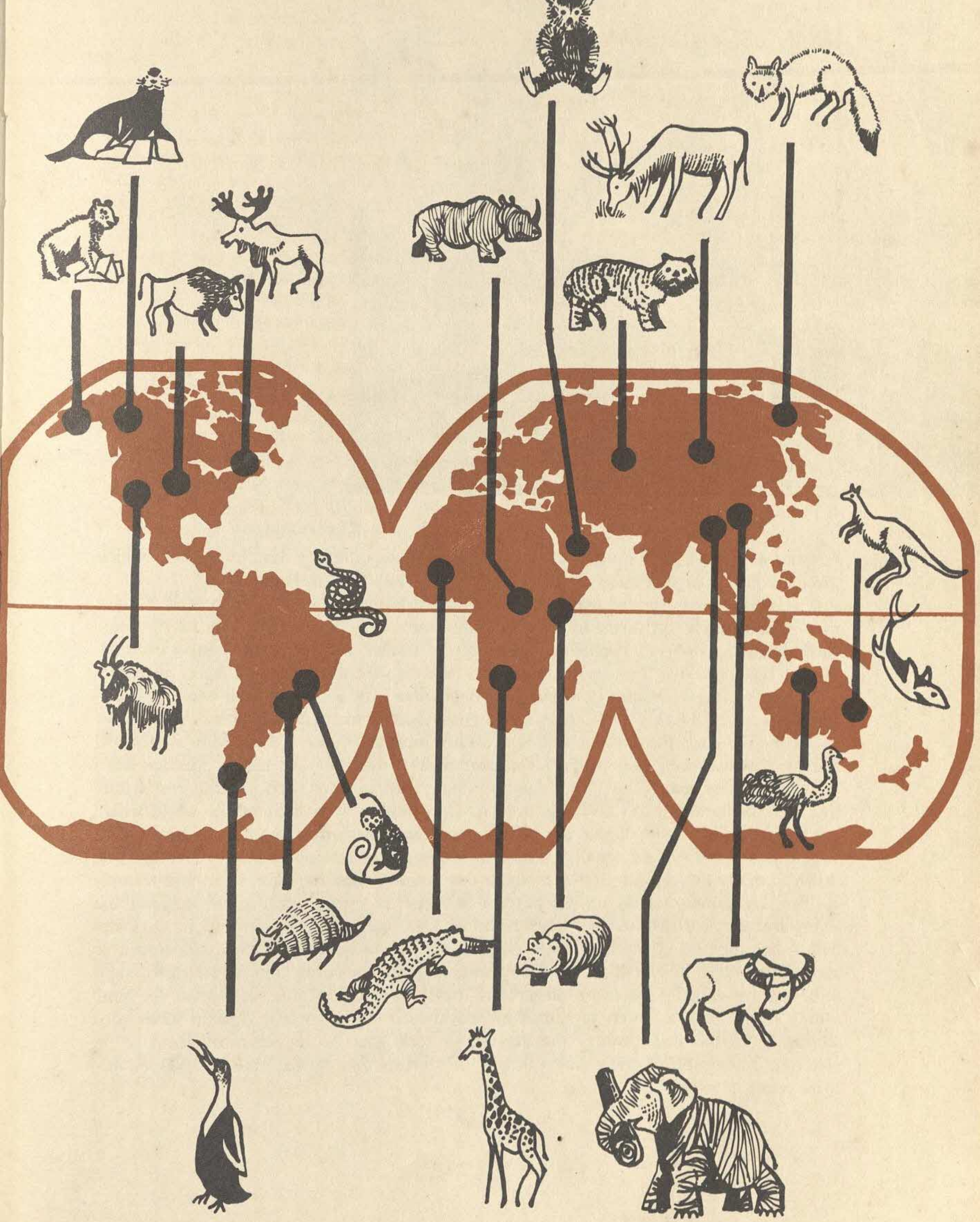
Among the books on our library shelves are many which bear the title 'History' and which tell the story of our past in many different ways. Some relate the lives of kings and statesmen and give accounts of the battles which they won or of the laws which they made; others tell of inventions and discoveries and show how they affected people's lives. There are histories of houses, histories of transport and histories of clothes; and all of them help us to understand a little more about the past. There are so many books already that there might not seem to be a need for any more, but a new type of history book could be written—one in which governments and armies would hardly be mentioned, but which would have as its chief characters various animals.

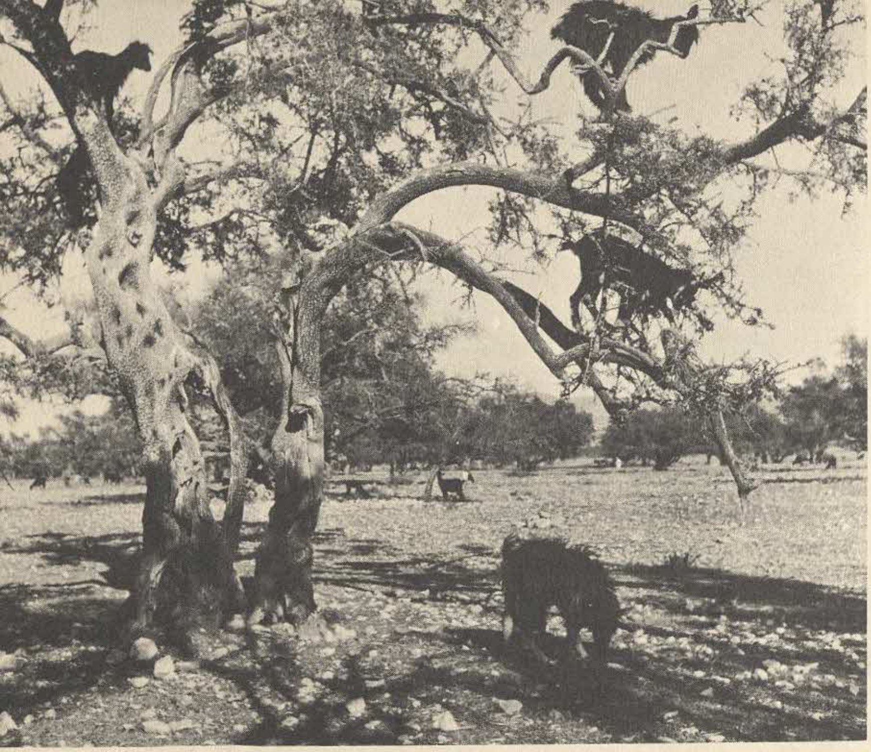
The first chapter would tell of the deer, the wild cattle and the hairy mammoths which prehistoric Man hunted and depended upon for his food. Next it would tell how animals were DOMESTICATED and how cows and pigs came to live in fields, or to be watched by herdsmen, instead of being free to wander where they wanted. The horse would have a chapter to himself and we would learn, amongst other things, of his strange adventures in the New World. The Spanish CONQUISTADORES took horses of the Andalusian breed to South America and rode them against the natives, who were so terrified at what seemed to be two-headed sword-bearing animals that they lost heart and were beaten easily by a handful of Spaniards who took the land and settled there. The horses made themselves at home too—in North as well as in South America. Some left their masters and, from the chargers of the 16th century Spanish adventures, descended the *mustangs*—the wild horses of the prairies. Within 300 years there were about 2,000,000 of them in North America, but today there are only about 20,000 left. Hundreds of thousands were rounded up to be killed and turned into meat for dogs and cats. Thanks to the efforts of a few people, who feel that a tin of pet food is a sorry end for a noble animal, the *mustang* is protected in a few American states. The wild horse is not only a reminder of the exciting days of the Wild West; he can also be a useful friend to the stockman, for in winter his hooves break the ice on frozen pools and thirsty cattle share the water with him.

Horses have almost disappeared from our roads and farms as INTERNAL COMBUSTION engines have taken their place. A working horse eats a large quantity of oats, whereas tractors and lorries need no food. Today more land can therefore be given over to growing corn for humans, so it would seem to be a good thing that horses are disappearing. But there is much to be said in favour of using horses on farms for they provide manure which tractors cannot do! Tractors plough more quickly than horses and this helps the farmer to cultivate more land, but perhaps it would be better if ploughs moved more slowly, for the fast tractor-drawn plough does not allow time for the birds to pick out the grubs and insect pests from the newly turned earth.

In making a journey through the countryside today we would see very few of the great 'shire' horses, once valued for their strength; for the popular horse of today is the riding pony. Over the centuries Man has changed the appearance of his other domestic animals too. When oxen drew ploughs and carts cattle were valued most if they were bony and muscular. In the days when families were large and the Sunday joint had to feed many children and servants, farmers looked for big animals which were heavy with flesh. Now

How many of the animals opposite can you recognise?





The argan tree is vital to many Moroccan families for it provides, in a dry, rocky land, both cooking oil and cattle food. If these goats have their way, however, the tree will be destroyed.

(Photo: UNESCO/Gerda Bohm)

farmers want cows which will give two or three gallons of milk a day; or bullocks which grow up quickly to provide small lean joints suitable for a modern family.

The cattle breeder has to select animals which will give the best value in food to their owners and which will thrive in the conditions where they have to live. One of the great cattle breeders, Robert Bakewell, an 18th century farmer, is often mentioned in ordinary history books; so our 'History of Animals' would be sure to contain a chapter on cattle.

Not every chapter would be about good characters—the animals which benefit Man—for not even all DOMESTIC animals do that. One of the bad characters in our story would be the goat, for, although he is generally included in our list of 'Man's farmyard friends', he has been responsible for a great deal of damage. The nanny goat has been called the 'poor man's cow', and certainly many people have been glad of goat's milk and the cheese which can be made from it. Unfortunately the areas of the world where goats have been most popular are usually the areas where they should not be kept. It is said that goats will eat anything and this is thought to be a point in their favour. The truth is that they will eat anything which one would rather they left alone and trample on the tasy morsels which are put in front of them! If tethered near a tree they will eat every leaf within reach and will even climb into its branches; they strip off its bark and kill young saplings. If nothing more exciting than grass is available they will crop it so close that it dies. In North Africa where herds of goats have been kept for centuries, their nibbling has killed vegetation, encouraged SOIL EROSION and so helped the sand dunes of the Sahara Desert to spread more widely over what was in Roman times good cornland. In the 15th century the Portuguese took goats to the Atlantic island of St. Helena. They nibbled their way through the forests and turned tree-clad slopes into bare rocky hillsides.

Goats destroy the land; but the busy beaver, so often blamed for causing destruction, has provided North America with some of its best farmland. The beaver has a habit of building dams across rivers and making ponds which sometimes flood roads and railways. Engineers do not like this and they suggest that beavers should be shot or driven away. But those who know more about life in the wild point out that the beaver's dams make ponds from which other animals may drink; they control the flow and prevent floods in the lower reaches of the river, in the same way that the Man-made dams on the Tennessee River prevent the farms of that valley from being flooded—but no one has to pay the beaver millions of pounds for the work he does! What is more, when beavers abandon their lodges, the dams gradually fall to pieces, the water drains away and a layer of good rich soil is left behind.

Other wild animals have also played important parts in the history of North America. The fur-bearing animals of the north—the marten, mink and silver fox attracted the trappers and traders who were among the first to settle in Canada. Further south on the prairies lived an animal which is so well known that it is one of the *symbols* of North America. Its story is sad, however, for it has only just been saved from EXTINCTION. Just over 100 years ago there were about 60,000,000 *buffalo* in the U.S.A. For hundreds of years they had been hunted by Red Indians whom they had provided with meat and buffalo robes, but the number killed by the Indians' stone-tipped arrows was never very large and enough young buffalo grew up to take the place of the hunted. But the white man came with horse and gun, burning the forests and ploughing the prairies, streaming across the West in wagon trains, and following up with a railway from Atlantic to Pacific. To the pioneers the buffalo was a walking meat store and thousands were shot by the rifles of such hunters as 'Buffalo Bill' Cody. Now the great animal is protected and a few hundred of them live peaceful lives in government parks where they remind the visitor of the exciting early days of the United States.

But it is not only large creatures nor those animals which share the land with Man which have played important parts in his story, for herrings would also find a place in our history book. In the 15th century these tasty and nourishing fish left the Baltic Sea, where they had lived for hundreds of years, and swam into the Atlantic Ocean. The once wealthy sea-port towns of the northern German coast became less important and fishermen turned their attention to the fishing grounds of the Atlantic. Amongst the earliest voyagers to Newfoundland and the North American coast were Breton fishermen who were more interested in the wealth of silver fish in the shallow waters of the Newfoundland *Grand Banks* than in the fabled gold of the American continent.

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In some of the old stories we hear how animals big and small helped to change the course of history. At one end of the scale were the elephants which the Carthaginian general Hannibal used against the Romans as a modern general would use tanks to frighten his enemy. At the other end of the scale is the mosquito which bit Alexander, conquerer of half the world, and gave him MALARIA from which he died at the age of 33.

Animals are still affecting our lives although perhaps not in such dramatic ways as these. As the world's population grows the animal kingdom becomes more important than ever, for animals and Man are often rivals for food which the soil provides, and one may flourish at the expense of the other.

OUT OF NOAH'S ARK . . .

. . . after the waters receded, came 'every beast, every fowl of the air and every creeping thing'. The legend in the Bible tells how Noah took into his ark and saved from the Flood two of every creature upon Earth.

Noah had no choice but to save all animals, though we might wonder how he felt about taking with him such unattractive creatures as rats and fleas and poisonous snakes. If Man today had Noah's opportunity, but was free to choose his passengers, would he do as Noah did or would he look at every animal and wonder if it was likely to be useful to him or not? It would be almost impossible to make a fair judgement for biologists are only beginning to realise the effect which animals have upon Man or upon each other. Certainly a modern Noah would owe it to the animals to take them all aboard his ark, for already Man has been responsible, through his greed or carelessness, for the disappearance of several SPECIES. If all the wild animals of one type disappeared from the world our food supplies might not grow any smaller and most of us would carry on as before, but something would have been lost which could never be replaced.

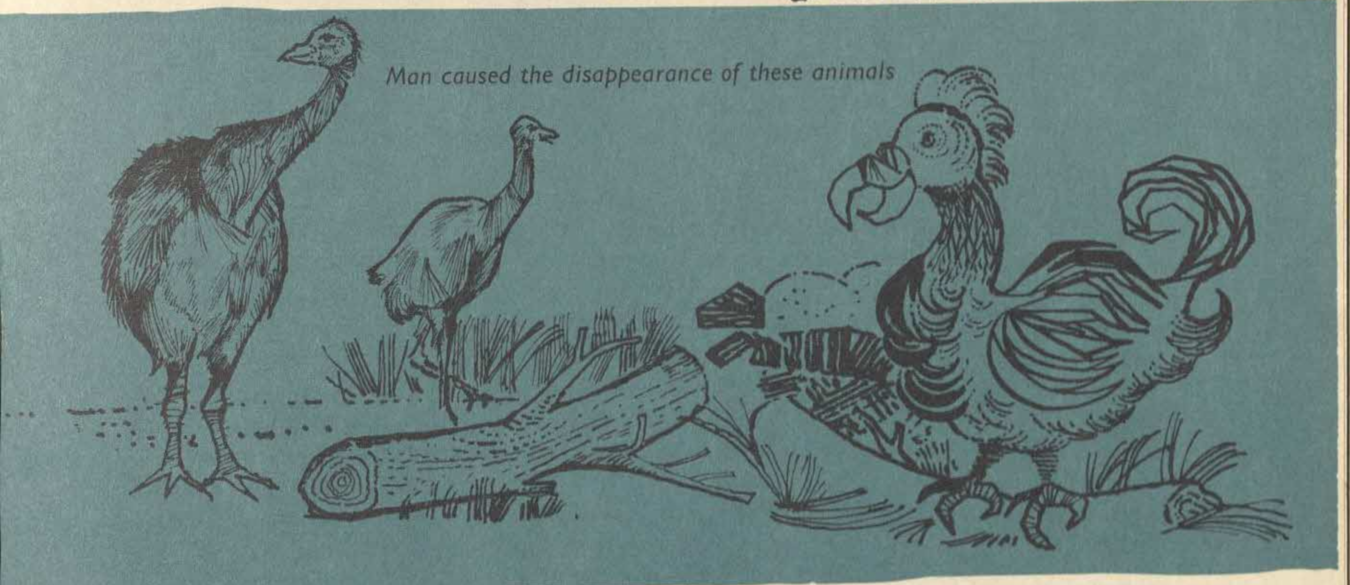
Once the North American skies were darkened every year by the flight of Passenger Pigeons; but the guns of 'sportsmen' and the axes of the settlers, which destroyed their nesting trees, caused them to become EXTINCT within a few years. There was no safety in the air for the pigeons and none in the water for a creature of the sea. A trusting and harmless animal known as Steller's Sea Cow was ruthlessly hunted for the sake of its skin and fat until it disappeared. If the hunters had been less greedy this animal would not be just a museum specimen but would usefully be providing skin and blubber for those who need it today.

Before Captain Cook arrived in New Zealand huge ostrich like birds, 9 feet high still roamed the South Island. Now all we know of the *Moa* are its remains. Until 1681 the stupid *Dodo* lived on the island of Mauritius, but now this bird is only remembered in the saying 'as dead as a Dodo'. If there were a few of either of these birds still alive they probably would not be much use to us as providers of food or clothing, but we can imagine how tourists would love to see them, or how camera men would follow and study them in order to bring their pictures and stories to our screens.

Through the cinema and television many of us have come to know quite well such animals as lions, giraffes and elephants which we saw in our ABC books and learned that they live in Africa. These animals are now in serious danger and it is possible that our children or grandchildren may only learn of them from books about EXTINCT animals. Fortunately some people are beginning to realise that the world would be a poorer place without its wild life. That the animals are beautiful or interesting is enough reason for most of us to hope that they will not die out, but there are other reasons. Many tourists visit Africa; a few still come with guns so that they can boast of the antelope head hanging on the wall, but more of them now come armed with cameras to study and film animals in their proper surroundings. These tourists bring money into Africa and quite a large industry has developed in order to provide them with hotels and transport.

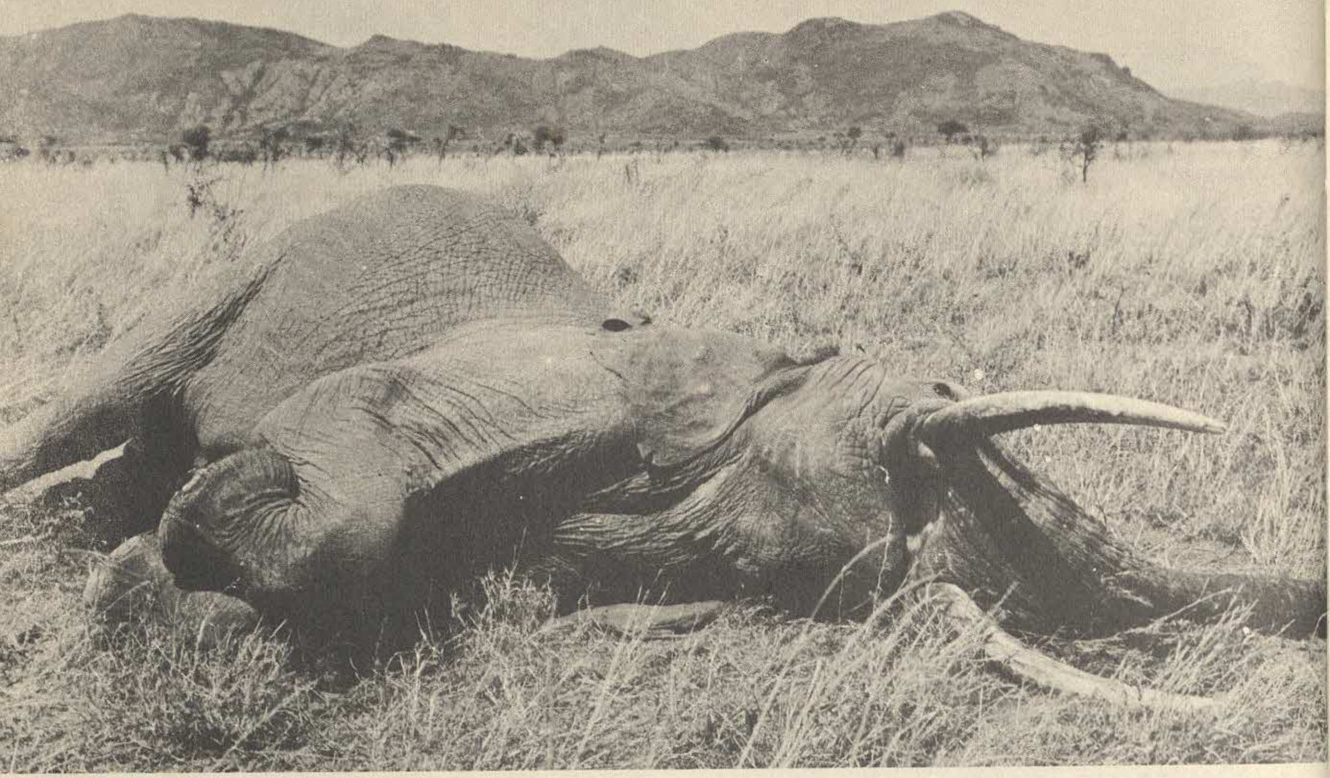
Although game wardens and rangers are striving to preserve wild life they sometimes find that a few animals have to be shot lest they grow too numerous and eat more than

These animals became extinct long before Man appeared



Man caused the disappearance of these animals

Man is trying to preserve these animals



The death of this elephant did no-one any good for neither meat nor ivory has been taken from the body. He was killed by poachers in the Kidepo Game Reserve, Northern Uganda. (Photo: UNESCO)

Man is learning that he has a duty towards animals. This deer is one of many whose lives were threatened by the rising waters of Lake Kariba. (Photo: Paul Popper Ltd.)

their fair share of grass. A thousand hippos have to be killed each year and their meat is sold cheaply to African tribesmen who otherwise would not be able to provide their families with sufficient PROTEIN to keep them in good health. A farmer would not kill and sell all his beef cattle at once in order to make a large profit, as he needs to rear more bullocks for the years to come. Similarly if wild animals instead of being slaughtered wholesale, are hunted carefully by those who know how many can be spared, there will always be a supply of meat and nothing will be wasted.

We are used to thinking of meat as a food provided chiefly by DOMESTIC animals such as sheep, pigs or bullocks; and perhaps we wonder why the grass lands of Africa could not be given over to cattle as are the PAMPAS of Argentina, so that the African need never be short of meat or milk. Unfortunately for the herdsman it does not seem as if it will be possible to do this on a large scale for it is now known that much of the African bush can only be made fit for cattle if expensive work is done to clear away bushes which provide shady breeding grounds for the dreaded *tsetse-fly*, the enemy of cattle.

Wild animals seem to be able to avoid the sickness *nagana* carried by the *tsetse-fly*; and, if they are allowed to roam the grass lands, they can thrive where cattle would die of sickness and starvation. Then a few well-aimed bullets from a hunter's rifle could provide hungry Africans with more meat than could a farmer after months of hard work caring for a herd of cattle.

Just as in other countries people keep large cars or expensive dogs in order to impress their neighbours, so many Africans keep herds of thin unprofitable cattle as a sign of wealth. These cattle have helped to make life hard for the wild animals for they eat their food and drink their water. If too many cattle are set to graze on poor land the grass may be destroyed so that SOIL EROSION begins. Wild animals, however, do not harm the land for Nature only permits them to live if food is available and the many different varieties share the food according to their needs. Thus antelopes eat grass, rhinos eat thorny shrubs, and giraffes eat leaves and shoots from high tree branches, so that these three animals can live side by side without robbing one another.

The chief enemy of African wild life is not the herdsman or his 'scrub cattle', but the poacher. With poisoned arrows, cruel wire traps and pits lined with pointed stakes the poacher kills hundreds of beasts without pity or regret. For the sake of ivory which he sells at 1s. 6d. per pound, but which is really worth 40 times as much, he may kill a herd of elephants, hack out their tusks and leave their bodies to the vultures and ants. The tails of the gnu and the giraffe make good fly swats, and for this reason alone an animal may be made to suffer and die with its foot caught in a wire loop. Many a rhino has been strangled so that his horn could be removed for, in the Far East, rhinoceros horn which has been ground to a powder is prized as a stimulating drug.

Against the poachers the game wardens do what they can, but they are few in number and they have to patrol vast areas of land. If animals can be kept inside the great National Parks (which are unfenced) they will be safe, but unless there is water for them they will not stay. One of the big tasks, therefore, is to sink boreholes and install pumps to provide drinking pools inside the protected areas. Then the animals which wander in, or which are rounded up and brought in for their own good, will remain with nothing to fear except the claws of a hungry lion or an occasional bullet from a licensed hunter killing for food.

Africa is the home of the great animals, the royal lion and the noble elephant; but Australia is a museum of curious creatures. There live two animals which now are scarce but which Man can no longer be accused of hunting to death. They are the strange Duck-billed Platypus, an egg-laying MAMMAL with webbed feet and furry coat, and the Koala Bear, which looks very like a child's teddy bear. They are looked after carefully in places safe from their enemies and where there is a plentiful supply of eucalyptus leaves, the Koala's main food.

These little animals are neither harmful nor useful, but we have decided that they would certainly be given a place in a modern Noah's ark. Unless some more places are found quite soon, however, many of our old friends of the zoos will one day be as dead as the *dodo* or the DINOSAUR!

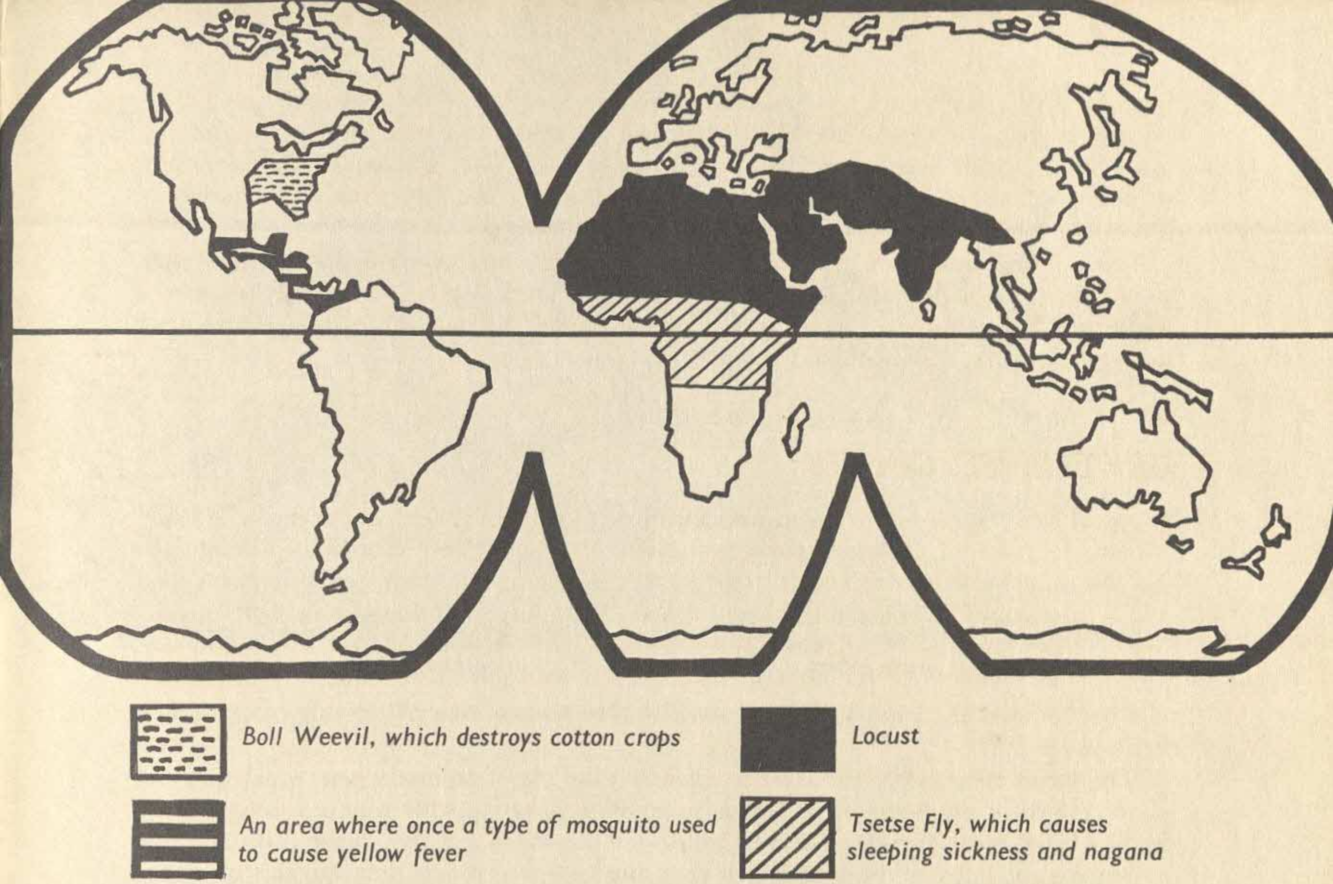
UNWELCOME GUESTS

It would be a foolish businessman who left money in the tills of his shop, and who made life easy for thieves by scorning police protection. He could expect to be robbed frequently. No one would do this for human thieves but, in making sure that he has enough food and a safe home, Man has made life very easy for a large number of thieving animals. Many birds of prey and CARNIVOROUS animals have disappeared from the countryside around our homes. The last wolf in England was probably killed about the beginning of the 16th century, and the wild cat and the golden eagle are now found only in lonely parts of the north of Scotland. Life has been made easier for rabbits, rats and squirrels because Man has killed or frightened away many of their former enemies. Man grows fields of corn or orchards of fruit which he stores in barns or lofts, and unintentionally provides plenty of food for pigeons and rabbits, rats and mice, locusts and weevils.

The pests have not been asked to share our food but, as humans have spread themselves over the world and harvested crops, so have the numbers of rats, mice and rabbits grown too. Man, who made things easy for these robbers which faithfully follow him around, now has to turn hunter himself in order to restore the *balance of Nature* which he disturbed when he dismissed the original police force of hunting animals. Sometimes he gets new 'policemen' to help him—but not always with happy results . . .

Rats came to Jamaica without being invited, for they crept ashore from boats which visited the island. They thrived on the sugar cane which is grown there and the warm climate suited them so well that they became a serious pest. It seemed a good idea to bring to the island some mongooses for they are enthusiastic eaters of rats and snakes. As was expected the mongooses made short work of the rats, and the sugar cane growers were happy until they realised that their crops had begun to suffer from a plague of insects. The mongooses were to blame, for when they could find no more rats to eat they began to eat the fledgelings and eggs of birds which feed on insects. The *balance of Nature* was restored only when a way was found of reducing the numbers of mongooses.

Rabbits are a pest in Europe but they still have some enemies which prevent them from becoming too numerous. When rabbits were taken to Australia however, they were introduced to a land where they had no natural enemies. Within a few years they had spread themselves so widely that they became one of the worst pests a farmer has ever had. Five of the little animals eat as much as one sheep and between them the rabbits of Australia take the grass which would support about 40,000,000 sheep. It is not surprising that when the disease *myxomatosis* killed most of the rabbits, Australians felt glad that they were going to be relieved of a pest which they had not been able to get rid of themselves.


Boll Weevil, which destroys cotton crops
Locust
An area where once a type of mosquito used to cause yellow fever
Tsetse Fly, which causes sleeping sickness and nagana

Map showing parts of the world which suffer from certain pests.

When the disease reached Europe not everyone welcomed it for many people like rabbits and it was easy to see that the animals which caught it suffered a great deal before they died. It was found too, that as the rabbits disappeared, foxes and weasles which had been used to feeding on them, turned their attention to the farmers' chickens and it seemed as though a new pest had come to take the place of the old. We still see rabbits in our fields and woods for some were able to resist the disease and soon they were back—nibbling at the young trees, stealing the farmers' crops and, in their turn, providing food for foxes.

Although it is an expensive business it is possible to prevent rabbits from spreading by erecting fences of wire netting. No fence, however, will keep away locusts, the winged pests of the Middle East. These insects eat their own weight in green food every day and, as a swarm of them may contain a thousand million and weigh altogether 50,000 tons, it is not surprising that, after the locusts have passed, the once green land resembles a desert. As locust swarms ride upon the wind the METEOROLOGIST is often able to give warning of their approach. The warning may give little comfort to the farmers whose fields lie in the locusts' way but it will help the locust fighters to know where next to attack their enemy. Experts of F.A.O. from 20 countries, have joined together to fight locusts, spraying them with insecticide when they are air-borne, and in their breeding places on the ground. We know from reading our Bibles that locusts plagued Man 3,000 years ago. Perhaps in our own day they will be beaten, for the world needs all the food that

On the left is a single locust . . . Here a swarm of them darken the sky. (Photo: Paul Popper Ltd.)

can be produced and cannot afford to sacrifice thousands of tons of growing crops to their restless jaws.

The locust is probably the most frightening example of an insect pest which eats our food; but there are many others which, in addition to eating what we need for ourselves, spoil what they do not eat. Cockroaches do not eat much but they make dirty and give an unpleasant smell to the food which they touch. A weevil may only eat part of a bean but we do not gratefully eat what is left for we do not care to compete with insect grubs for our food.

To most of us insects and their grubs are unpleasant creatures and our dislike of them has grown as we have learned how some of them spread diseases.

It used to be thought that MALARIA which has caused so much misery, particularly in tropical countries, was caused by breathing the 'bad air' of swamps. It is now known that it is caused by a PARASITE in human blood and that the parasite is carried from person to person by the female ANOPHELES mosquito. Malaria is not a disease which kills immediately, but it shortens life and weakens those who suffer from it so that they cannot do their work. It often happens that there is an epidemic of the disease at the time of harvest so that the crops have to be left ungathered in the fields and people go hungry in the midst of plenty.

Two wars are being waged together; one aims at wiping out malaria altogether so that the bite of mosquitos, although unpleasant, need not be dangerous. This war is fought with anti-malaria drugs and with DDT which is sprayed inside the houses of malaria sufferers. If a mosquito then bites and sucks some of the sick man's blood it will probably rest for a moment on the wall and absorb DDT through its feet. The poison should kill the mosquito before it has bitten anyone else. In the other war against the mosquitos themselves there are many weapons. The female ANOPHELES lays her eggs in stagnant water so, if marshes are drained there will be fewer nurseries for mosquito LARVAE. Spraying them with paraffin or poisonous dust kills LARVAE, but this method is expensive and may harm other inhabitants of the pool. A type of minnow feeds on larvae so

After the locusts have gone—everything green has been eaten and these plants will soon die. (Photo: Paul Popper Ltd.)

sometimes pools are stocked with these useful fish; or certain water weeds which discourage mosquitos may be introduced to the pool. On a group of Pacific islands an attempt is being made to spread sickness amongst the mosquitos themselves. Scientists have put larvae infected with a fungus in places where mosquitos are known to breed. It is hoped that they will infect each other and die off. If the plan is successful there may be a chance of wiping out the disease *filariasis* which is carried by another type of mosquito and which causes some people in the tropics to suffer with limbs so swollen that they look like the legs of an elephant.

The war against the mosquito will continue for a long while, for there are several diseases carried by several different varieties of the insect. Some of their tastes and habits vary, so different ways of fighting them must be tried.

Another insect against which chemical warfare may be waged is the *tsetse fly* of Africa which injects into the blood of its victims certain PARASITES which cause *sleeping sickness* in humans and *nagana* in cattle. To spray the land is expensive and may cause harm to other animals, so the *tsetse* control officer tries to keep the fly from invading his territory at all. By controlling the movements of wild animals which may be carrying the flies, and by ensuring that no human visitors unintentionally bring flies with them, he hopes to make the country free of the pest in one small area at a time.

Whenever possible it is usually better to try to control a pest, either by preventing its spread or by destroying its breeding places, than by using poisonous chemicals. Although many chemical sprays have been developed to poison field pests it may not be wise to use them too freely. Some pests EVOLVE and build up a *resistance* to poisonous sprays, as rabbits have built up a resistance to the milder forms of *myxomatosis*. A strong spray may damage the crop itself or give it a queer taste. There is also the risk that harm may be done to useful creatures. If worms were killed by chemical sprays and fertilizers great damage would be done to the soil, for worms break up ORGANIC matter, turn the soil over and let air into it. Poisons might also kill birds which eat grubs and so upset the *balance of Nature* in unthought of ways.

With helicopters large areas of cropland may be sprayed quickly and easily.

It may be that already Man has done himself an injury by banishing birds from his fields. Farmers like big open fields instead of small ones surrounded by hedges, as they are easier to work with modern machinery. Unfortunately bigger fields mean fewer hedges and fewer homes for birds. Some farmers may have unwisely destroyed their hedges and replaced them with strands of wire which allow the ploughs to work closer to the edge of the field and so give the farmer an extra yard of land. But birds cannot live in wire fences and therefore the grubs on these clean, neat farms have fewer enemies.

Man's relations with animals are very complicated and one of the most important sciences of today is ECOLOGY which helps us to understand how the *balance of Nature* works. Some of the pests' worst enemies are other animals and it would be shortsighted to try to make a land where only chosen farm animals grazed and where no birds were allowed in case they stole some of the corn. Each animal is like a link in a chain, and if one link is weak the whole chain is affected.

A little story is sometimes told to show how long such a chain may be . . . Someone suggested that people should give up keeping cats as they did no good but only drank a great deal of milk which is needed by human beings. Perhaps it was an ECOLOGIST who replied, 'But cats help to feed us! Cats catch field mice, field mice eat bumble bee LARVAE, bees carry pollen from plant to plant and encourage clover to grow; so field mice are harmful to clover which is the food of beef cattle. Therefore if you have fewer farmyard cats there will be more mice, and fewer bees will live; so there will be less clover in the fields, bullocks will not grow fat and people will have less to eat!'

'And that', said the ECOLOGIST, 'is a very simple story; some of the ways in which animals, birds and insects affect one another are really complicated'.

OUR WONDERFUL WORLD

'Has the horseless carriage come to stay?' is a question many people asked in the early days of this century. We know the answer now for motor cars have been so successful that we have to worry about providing enough good roads for them to run on. It would save road engineers a great deal of worry if it was decided that no more cars should be built and that only special people should be allowed to own them. That would be one way of solving the problem but it is not a way that most of us would approve.

Man's own problem is rather similar to that of the motor car. When the earliest humans huddled together on wet cold nights to keep some warmth in their naked bodies, and hunted for food with their bare soft hands a SABRE-TOOTHED TIGER might well have remarked to a MASTODON, 'Has this creature without fur, fangs or claws any chance of surviving in our hard, cruel world, all the forces of Nature are against him?' The *sabre-toothed tiger* and the *mastodon* have disappeared but Man has shown that he came to stay. So well has he survived that now his problem is to find enough space to live in and enough good food to support his rapidly growing numbers. Because Man has a better brain than any other animal he has been successful in his struggle with Nature, but because he wants to be sure that he will continue to be safe and successful the struggle still goes on.

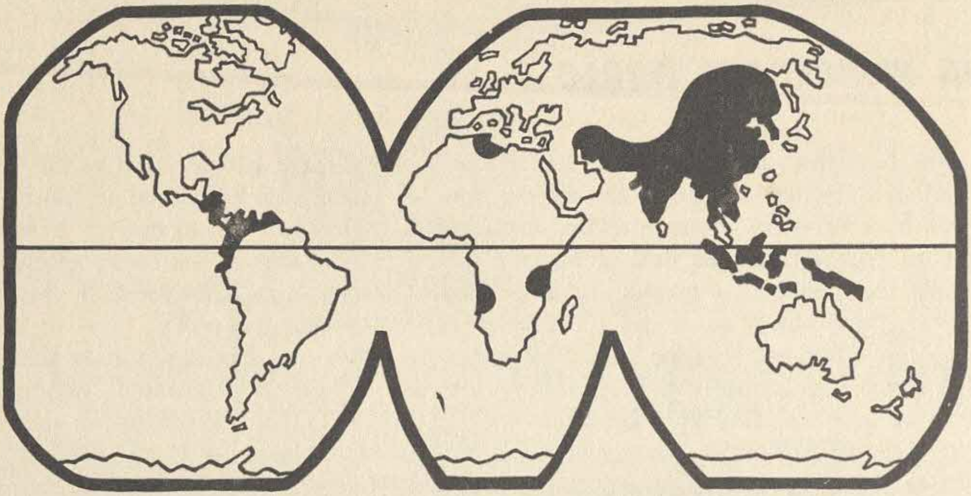
Already he has learned how to live in comfort almost anywhere in the world, how to provide himself with many different types of food, how to overcome mountains, seas and deserts and how to make plants and animals work for him. He has learned how to make use of the treasures of the rocks and the power of the sun and the atom. No longer is he at the mercy of killing diseases nor does he live in ignorant terror of volcano, lightning or storm.

So safe has Man made himself on Earth that most of us can expect to live twice as long as could a boy or girl 2,000 years ago. It used to be common for children to die whilst still in their cradles; now, thanks to better methods of feeding and better medical care, it is unusual for this to happen. Rabbits multiplied in Australia because conditions were right for them; the human population of the world has multiplied because Man has made conditions right for himself.

At the time of Christ's birth there probably were about 200 million people in the whole world. Now there are that many in South America or Africa alone, and in India there are twice as many. The world's population is growing at an ever faster rate and has multiplied itself by three in not much more than 110 years. Now there are about 3,000 million people on Earth, but at the present rate of increase there could be twice as many within another 50 years; and if numbers still continued to grow for another 400 years or so there would come a time when people would be so thick on the ground that there would be 'standing room only'!

Of course the population will have to stop growing long before that for, no matter how hard farmers and fishermen work to produce more food, it is unlikely that they will be able to feed properly more than about three or four times the number of people in the world today.

People need houses which must be connected by roads, so that when a town grows in size some good farmland disappears under bricks and concrete. The more people there



Map showing parts of the world where people are under-nourished.

are the less land we have left to feed them. It is not surprising that many experts are beginning to worry about how many people there will be in 50 or 100 years' time, and hope that the number will not grow very much bigger.

When wild animals grow too numerous for the supply of food Nature lets the weaker ones die. We believe that it is wrong that any human being should be allowed to die because he is unfortunate and we know that all people have a right to good food and good health. Not only must we plan to feed more people in the future but we must see that all are fed properly. Now 1/3 of the world's people do not get enough of any sort of food to eat, and another 1/3 do not have sufficient PROTEIN or foods containing the *vitamins* which we know are necessary for our health. More food must be produced by farmers on the land and by fishermen on the sea. Perhaps in the future Man will learn to 'farm' the sea so that he can make better use of the wealth which it provides. He will also try better ways of farming the land, find new types of crops and develop new forms of food.

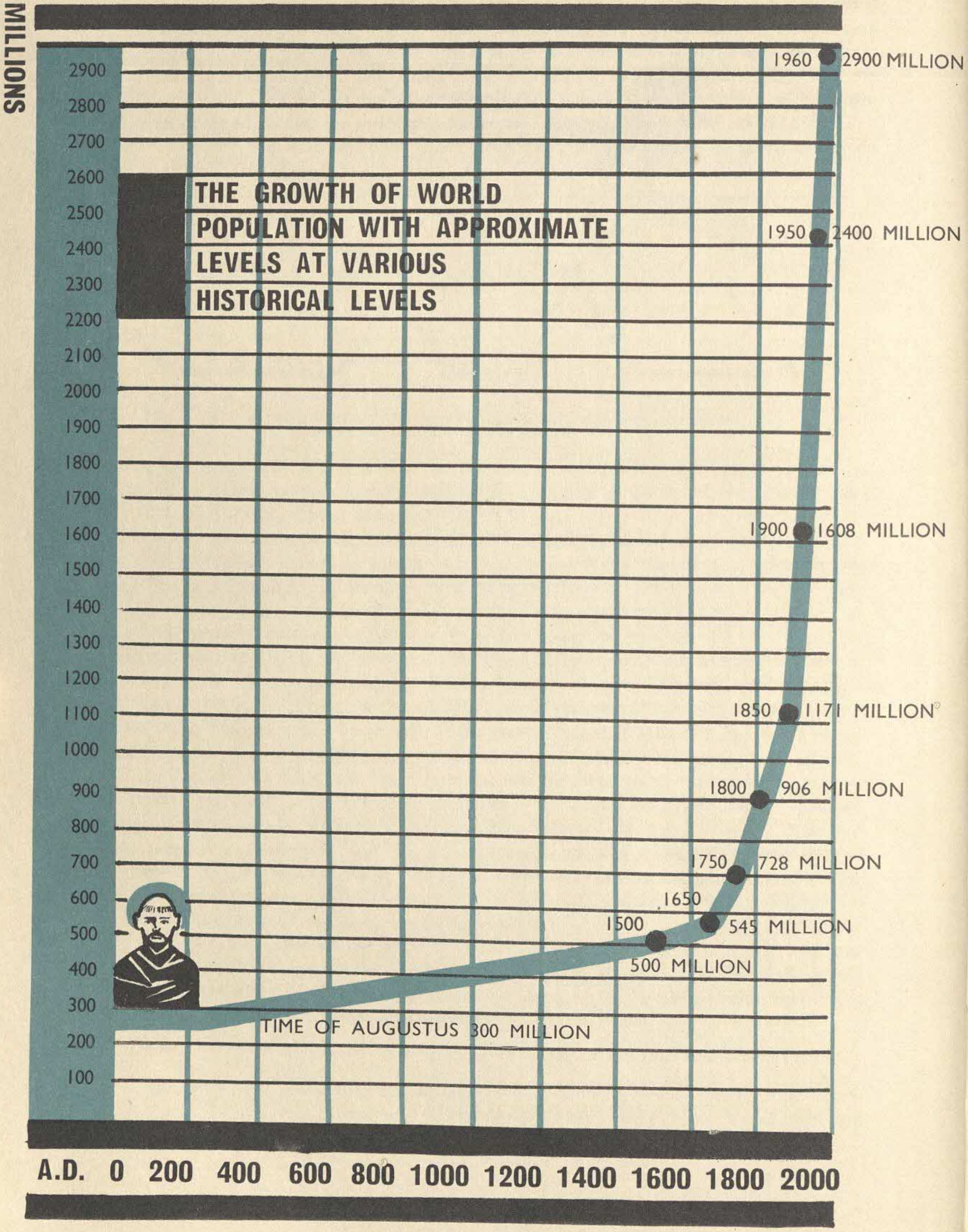
In order to do this Man must learn how to make the best use of the world, so that he may make himself even more safe and comfortable than he has been, and not hurt himself by his foolish treatment of Nature. We have seen some of the ways in which Man has done things to hurt himself—how he has destroyed soil, laid waste forests and poured filth into the rivers. Now he has a way of poisoning the air with his bombs. Every time a NUCLEAR explosion takes place in the ATMOSPHERE a certain amount of RADIO-ACTIVE dust is formed, and this travels in clouds around the world until it falls with the rain. Although our bodies do not seem to object to small doses of radio-activity, for our luminous watches and even some of the rocks on which we live, are slightly RADIO-ACTIVE, there is no doubt that a great deal of harm would be done to our health if a large number of hydrogen bombs was exploded.

* * * * *

If a person owns a pleasant house he may be interested in how it was built and how big its rooms are but he will also want to know how to take care of it so that all who live there will be comfortable. We are all part owners of the wonderful world in which we live and so we study the subject which at school is called *geography*. Some of the lessons tell us about how our home was made, how big it is and what its various parts are like. They are interesting subjects, but we should also think about what Man has done to harm or to improve the world, and try to decide what should be done in the future.

There may be other worlds besides this planet Earth but we are not likely to have the chance of living on them. Our world is a good home; let's look after it!

For hundreds of years the world's population changed very little, but now it is growing at an alarming rate.



FACTS AND FIGURES

The World:

Area of Earth's surface:			
	Land	57,510,000	square miles
	or	36,806,460,000	acres
	Water	139,440,000	square miles
	or	89,241,600,000	acres
Land and Water together		196,950,000	square miles
	or	126,048,060,000	acres
(There are 640 acres in a square mile)			
Population of the World (1962) about		2,900,000,000	

Highest Places:

Summit of Mount Everest	29,028	feet
Highest human settlement = the remains of a S. American Indian village, 100 feet below the summit of the sleeping volcano, Llullaillaco on the borders of Chile and Argentina.	22,000	feet
Highest inhabited building = Chacaltaya High Altitude Laboratory, 22 miles from La Paz, Bolivia.	17,180	feet
Highest pass = Nangpu La, used by yaks carrying salt and rice, Tibet.	19,050	feet
Highest motor road = the height of some of the passes on the Sin Kiang (China) to Tibet road.	18,000	feet
Highest point reached by railway = La Cima, Peruvian Central Railway.	15,848	feet
Highest railway station = Ticlio, Peruvian National Railway.	15,610	feet
Highest place of work = Ancanquilcha sulphur mine, Chile.	18,800	feet

Water:

An *AVERAGE* human needs to drink each day:			
In a TEMPERATE climate	about	6	pints
In the Sahara Desert	about	13 pints	
At work in the most intense heat of the Arabian Desert	about	3	gallons
Village people may use each day for all purposes	about	20	gallons each
Dwellers in a modern city may use each day (or have used for them by the authorities)		30 to 40	gallons each

GLOSSARY AND INDEX

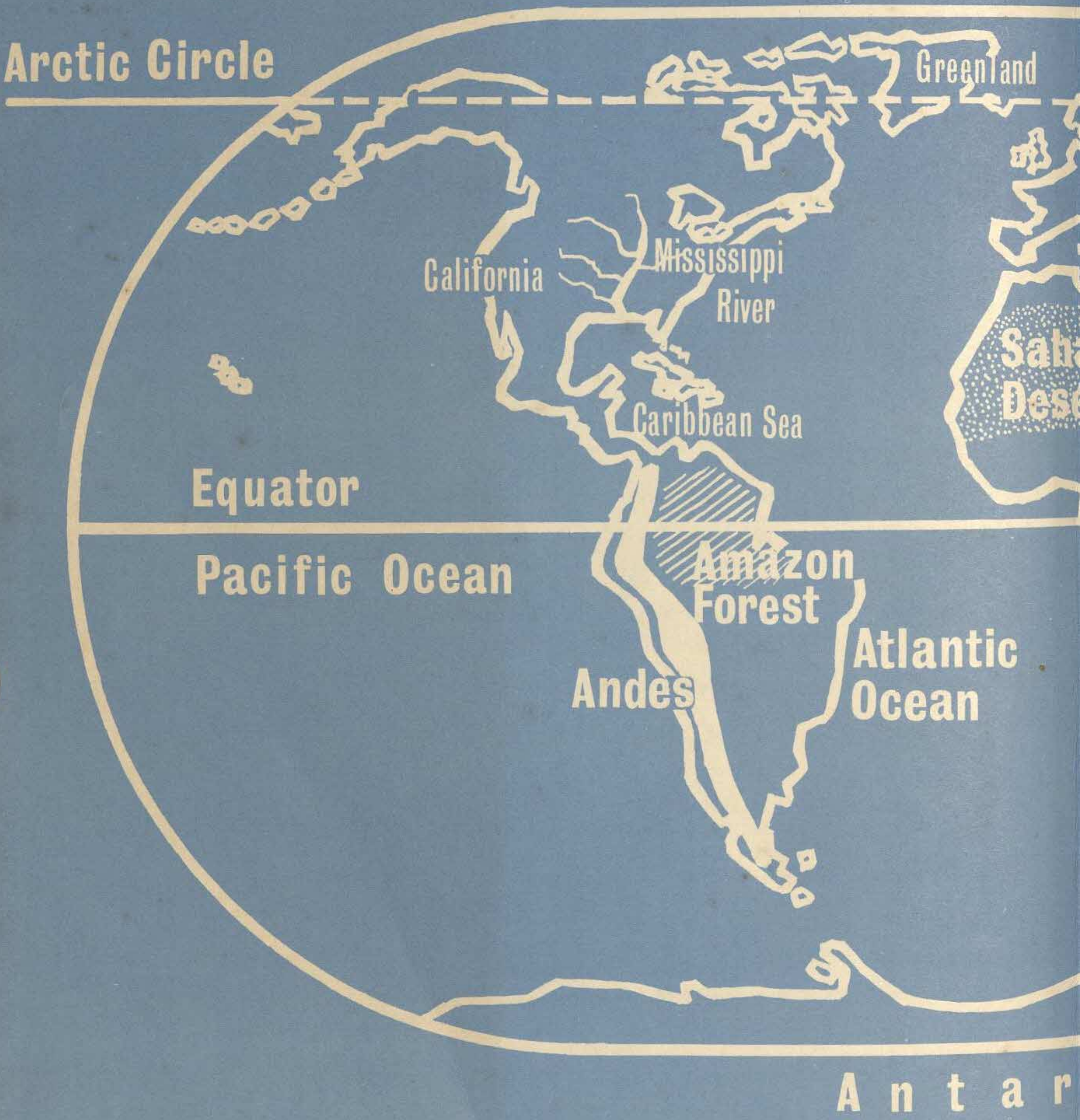
A list of words which are to be found in the book together with their meanings.

AMMONIA	A sharp smelling gas which dissolves easily in water. 30
ANEMOMETER	An instrument for measuring the speed of wind. 21
ANOPHELES	A type of mosquito which acts as host to the MALARIA PARASITE. 15, 54
ARCTIC CIRCLE	The line of *latitude* 66½ degrees N. The line marks the southernmost places where on June 21st the sun does not set, and where on December 22nd and it does not rise. 42
ATMOSPHERE	The layer of gases which form the air around a PLANET. 10, 18, 21, 31, 58
AVERAGE	A figure about half way between the greatest and the least; to find the *average* add all the quantities together and divide the total by the number of quantities. 7
BACTERIA	are sometimes known as 'germs' or 'microbes'. There are many different types; some are beneficial and some are Man's enemies. They may be as small as one ten thousandth of a millimeter and they live in water, soil, food, sewage and our own bodies. 28, 30
BAROMETER	An instrument which measures the pressure of the ATMOSPHERE. 21
BRONZE	an *alloy* or mixture of copper and tin. The *Bronze Age* was a period which began in Egypt about 5,000 or 6,000 years ago when craftsmen learned to use the *alloy* for making tools and weapons. 9
CARNIVOROUS	animals are those which eat the flesh of other animals. Animals which live entirely on plants are *herbivorous.* We eat all types of food and are therefore *omnivorous.* 30, 52
CHLORINE	A greenish-yellow gas with a choking, irritating smell. 26
COMPOST	A mixture of rotting vegetation, soil and manure which forms HUMUS. 30, 32
CONDENSE	To change from a gas to a liquid as when water *condenses* from the water vapour of the air. 23, 27
CONQUISTADORES	The Spanish conquerors and explorers of South America, especially during the 16th Century. 44
CONTOUR	lines on a map mark the outline of a hill and run horizontally through points which are the same height above sea level. 33
D.D.T.	A white, insect-killing powder with a fruity smell. 54
DINOSAUR	A prehistoric reptile. The word means 'terrible lizard'. 52
DOMESTIC	Connected with the home. Animals which have been *domesticated* are therefore tame and not wild. 44, 46, 51
ECOLOGIST	A scientist who studies ECOLOGY. 56
ECOLOGY	The study of how living things are affected by each other and by the places in which they live. 56
EROSION	Wearing away. 33, 43
EVOLVE	To develop through tiny changes or MUTATIONS, as, over long periods of time. Man *evolved* from a type of ape; and, more quickly, the supersonic 'plane *evolved* from the one built by the Wright brothers. 42, 43, 55
EXTINCT	Dead, when no more of a type or family are left alive. Prehistoric animals are extinct; they suffered *extinction.* 47, 48

EXTREME	An *extreme* climate is one which suffers the hottest or coldest, wettest or driest conditions possible. 8
F.A.O.	The Food and Agriculture Organisation of the United Nations. 53
GEOLOGICAL	To do with GEOLOGY. 26
GEOLOGY	The study of the rocks of the Earth's crust. 25
GORGE	A deep narrow valley with steel walls. 14
HEVEA	The rubber tree. 37
HUMIDITY	Dampness. Some days the ATMOSPHERE is more *humid* (contains more moisture) than others. 22
HUMUS	A vital part of the soil consisting of rotted animal and vegetable (ORGANIC) matter. 31, 33
IMPERVIOUS	substances can not be penetrated by moisture. 24
INSTINCT	Because it is born with *instincts* an animal usually knows what it should do without having to be taught even though it may never have tried to do it before. So a bird builds a nest of the same pattern as its parents'. 9
INTERNAL COMBUSTION	engines are powered by explosions of a mixture of gas and air in their cyclinders. They may run on petrol, paraffin or diesel oil. 44
IRRIGATED	land is watered by a system of canals and ditches. 14
LARVAE	The grubs of insects. 15, 54, 56
LAVA	Rock which was melted by the great heat of the Earth's interior, which poured from a volcano's crater and became solid again in the air. 13
LEGUMES	Plants which bear their seeds in pods such as peas, beans and lupins. They help to fix NITROGEN in the soil. 30
LYNCHETS	Stair-like marks on the sides of some hills which may have been caused by the ploughs of British people before the Romans came. 16
MALARIA	A disease in which the blood is infected by PARASITES carried by the female ANOPHELES mosquito. The word *malaria* is made from two words meaning 'bad air'. 14, 15, 47, 54
MAMMAL	An animal which feeds its young on milk from its own body. Reptiles, birds and fishes lay eggs but most *mammals* bring their young into the world alive. 52
MASTODON	A prehistoric animal which looked like a hairy elephant. 57
MEDIAEVAL	Belonging to the MIDDLE AGES—roughly the years between 800 A.D. and 1400 A.D. 6
MESOPOTAMIA	From two Greek words meaning 'middle' and 'river'. The land between the two rivers Tigris and Euphrates which is now in the country of Iraq. 14
METEOROLOGISTS	study and attempt to forecast the weather. 18, 19, 21, 53
MICROSCOPIC	So small that it can only be seen with the aid of a microscope. 28
MIDDLE AGES	A period of modern history—roughly from the 9th to 15th Century. 6
MINERAL	A substance which comes from the rocks of the Earth's crust. 10, 25
MUTATION	A change. If a plant or animal is a *mutation* it is slightly different from its parents. Nature usually allows efficient mutations to survive and unsuitable ones to die. When Man takes a hand he sometimes encourages a mutation in order to EVOLVE a more striking type of dog or an an unusual type of flower. 43
NATURAL VEGETATION	The types of plants which would be growing in a region if Man had not interfered with them. 11, 37
NITRATES	Chemical *salts* related to NITROGEN and nitric acid. 10, 30
NITROGEN	An invisible, odourless gas which makes up about 4/5 of the ATMOSPHERE. 30, 33

NUCLEAR	*energy* is released when atoms of a RADIO-ACTIVE material break up. In a *Nuclear reactor* this breaking up or *reaction* is carefully controlled to give great heat. In a *Nuclear explosion* the reaction is sudden and overwhelming. 58
OBECHE	A West African tree. 38
ORBIT	The path taken by a heavenly body. The Earth makes an *orbit* round the sun. 17
ORGANIC	To do with living things. Organic material was once part of a plant or animal. 31, 32, 55
OXYGEN	An invisible, odourless gas which makes up nearly 1/5 of the ATMOSPHERE. It is necessary to most forms of life. 30
PAMPAS	The TEMPERATE grassy plains lying around the River Plate estuary in South America. 51
PARASITE	A plant or animal which lives or feeds on another. 54, 55
PERENNIAL	Lasting; a *perennial* plant is one which lives for more than two years. 39
PLANETS	are heavenly bodies which revolve around a sun. Earth is a *planet.* 7
POLDERS	are areas of land reclaimed from the sea in Holland. 13
POROUS	substances have pores into which water can pass. 24, 25
PROTEIN	Chemical compounds which form a large part of all living matter. It is essential that our food contain some *protein* so we eat eggs, meat, fish or cheese every day. 30, 41, 51, 58
RADIO-ACTIVE	Substances are said to be *radio-active* when the *atoms* of which they are made break up of their own accord. Whilst this is happening rays known as *alpha*, *beta*, or *gamma rays* are given off. 43, 58
ROTATE	To turn around. By a famous system of crop rotation introduced into Britain by Norfolk farmers in the 18th Century; wheat, turnips, barley, clover are grown in turn upon the same land. 30
SABRE-TOOTHED TIGER	A prehistoric form of tiger with large, projecting, sword-like teeth. 57
SELECTION	Choosing; Man selects the plants he wishes to keep. When plants or animals die because they are unfitted to the conditions around them it is called *natural selection.* 43
SLUICES	Doorways through which water can be allowed to escape from behind a dam. 15
SOIL EROSION	Destruction and wearing away of the soil by wind and rain. 33, 35, 39, 46, 51
SPECIES	A group or type of plants or animals. 48
TEMPERATE	Neither as hot as the TROPICS nor as cool as the polar regions. 17
THERMOMETER	An instrument which measures temperature. 21
TROPICS	The region lying about the Equator between Latitude 23½ degrees north and Latitude 23½ degrees south. As the Sun's rays never slope very much within the *tropics* the weather is generally hot. 23
T.V.A.	Tennessee Valley Authority—the organisation in the U.S.A. which designed and controls the improvements in the Tennessee Valley. 15, 32
URANIUM	A hard, white, RADIO-ACTIVE metal. 10
WATER TABLE	The level reached by underground water held in POROUS rocks. 26
ZOOLOGIST	One who studies animals. 7

MAP OF TH



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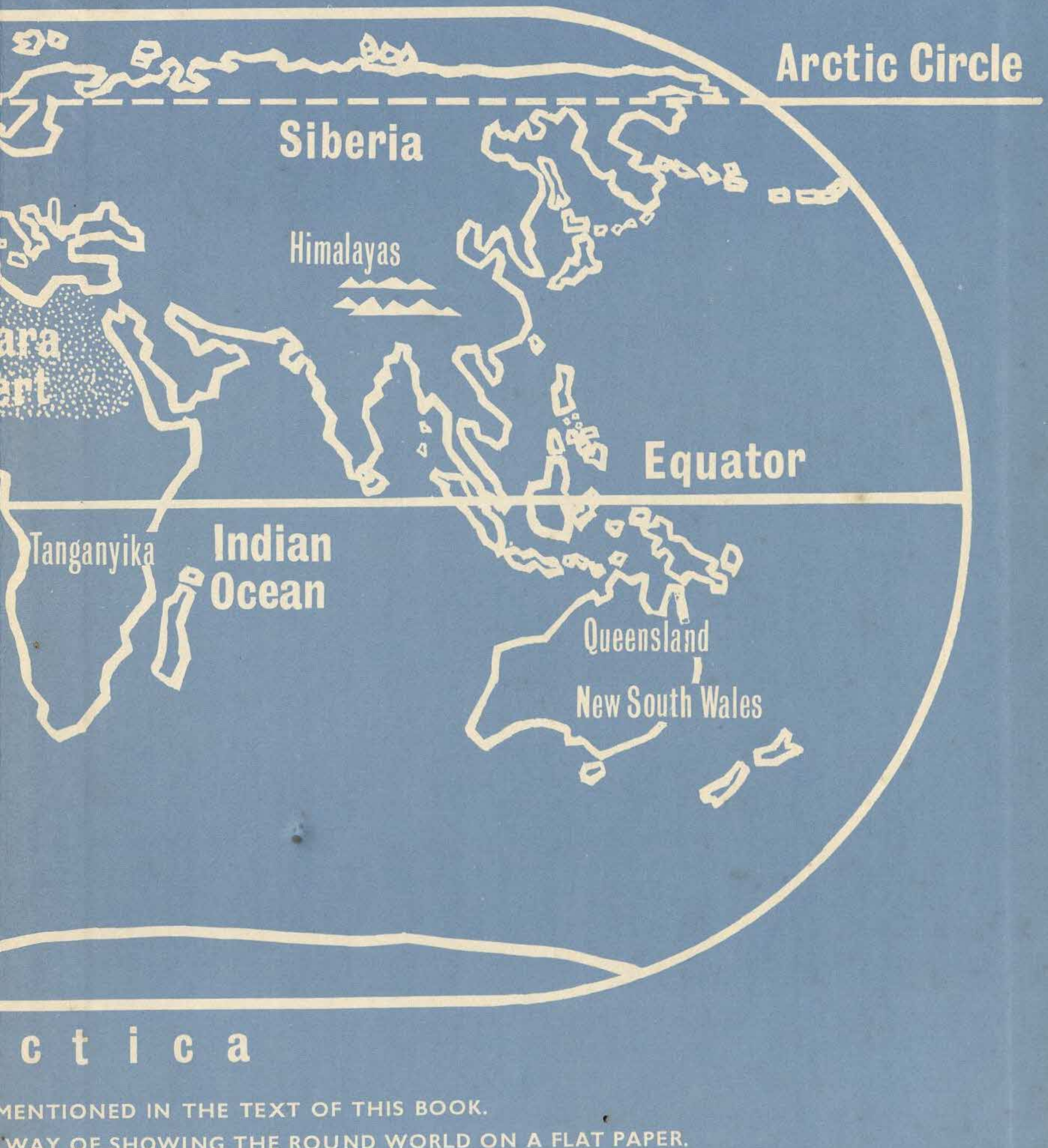
E WORLD



MENTIONED IN THE TEXT OF THIS BOOK.
WAY OF SHOWING THE ROUND WORLD ON A FLAT PAPER.